REPORT OF

THE BUREAU OF MINES

1900

CONTENTS

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO.

Toronto:
Printed and Published by L. K. CAMERON,
Printer to the Queen's Most Excellent Majesty,
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MAPS AND ILLUSTRATIONS.

WARWICK BRO'S & RUTTER, Printers,

TORONTO.

To His Honor the Honorable Sir Oliver Mowat, G.C.M.G.,
Lieutenant Governor of the Province of Ontario :

I have the honor to transmit herewith, for presentation to the Legislative Assembly, the Ninth Report of the Bureau of Mines.

I have the Honor to be, Sir,
Your obedient servant,

E. J. DAVIS,
Commissioner of Crown Lands.

Department of Crown Lands,
Toronto, April 25, 1900.

To the Honorable Elihu J. Davis,

Commissioner of Crown Lands:

Sir,—The Ninth Report of the Bureau of Mines is submitted to you herewith, for presentation to His Honor the Lieutenant-Governor.

I have the honor to be, Sir,

Your obedient servant,

ARCHIBALD BLUE,

Director.

Bureau of Mines,

Toronto, April 25, 1900.

REPORT OF THE BUREAU OF MINES

By Archibald Blue, Director

The records of the year 1899 furnish evidence that the mining industry of Ontario continues to expand and prosper. This is shown especially in the extent to which capital is being attracted, in the purchase of mineral lands from the Crown, and in the growing volume of production.

During the year there were incorporated under the Joint Stock Companies Act 74 Companies with a capital of $87,382,994, and in addition seven other Companies organized elsewhere were authorized by license to carry on business in the Province with a capital of $9,551,000. The following table gives the statistics for the first 28 years after Confederation and for the last four years, inclusive of licensed Companies :

Year.	No.	Capital.
		$
1868-95	120	46,929,389
1896	26	15,600,000
1897	140	101,531,000
1898	49	30,762,998
1899	81	96,933,994

The number organized and licensed during the thirty-two years is 416, and the amount of authorized capital is $291,757,372. Last year's Companies make a fifth of the whole in number, and rank as second in the amount of authorized capital during the whole period, being exceeded only by the record of 1897.

The next tables present the transactions in mining lands for the last eight years, the first showing the number and area of mining locations sold and the purchase money paid therefor, and the second the number of locations leased and the amounts paid thereon as rent. Included under this latter head is the money paid each year for lands previously leased, which is a steadily growing figure :[1]

[1] Although the Bureau was organized in 1891 the statistics for that year are not given in the tables, because the transactions included many locations applied for in the previous year before and during the time that lands were withdrawn from sale, and which therefore would not afford a fair comparison with the transactions of later years.

1. LOCATIONS SOLD.

Year.	No.	Acres.	$
1892	65	6,200	15,273
1893	63	4,370	11,489
1894	40	3,271	7,646
1895	99	7,720	15,868
1896	140	10,734	22,084
1897	472	29,794	59,478
1898	292	19,529	40,469
1899	294	35,049	75,367
Totals	1,465	116,667	247,674

2. LOCATIONS LEASED.

Year.	No.	Acres.	$
1892	95	13,122	12,917.36
1893	122	13,047	14,669.76
1894	66	7,051	10,296.56
1895	175	15,084	18,211.16
1896	161	13,224	18,504.14
1897	783	86,014	91,062.46
1898	506	48,911	57,493.25
1899	496	63,258	75,607.90
Totals	2,404	259,711	298,762.59

Adding the revenue from miners' licenses, etc., in the Michipicoton Mining Division for the three years 1897-9 ($11,223.50) the aggregate revenue from mineral lands during the eight years is $557,660.09, or an annual average of $69,707.57. The revenue for 1899, including miners' licenses, etc., is $155,953.90, which exceeds any former year.

The average size of locations sold during the period of eight years is very nearly 80 acres, and of locations leased 108 acres. For 1899 the average of locations sold is 119 acres, and of locations leased 127 acres, being higher than the averages for any year of the period excepting 1892, in which year the average of leased locations was 138 acres. The average of the 3,869 locations leased and sold in the eight years is 97 acres, and the aggregate is 376,378 acres, or 588 square miles.

Statistics of mineral production were incomplete for the first year of the Bureau's operations, but in the table which follows a comparison is made of the values of products in 1892 and 1899 :

Products.	1892.	1899.
Building stone, rubble, etc	$880,000	$1,041,350
Cement, natural rock	38,580	117,039
Cement, Portland	47,417	444,227
Lime	350,000	535,000
Drain tile	100,000	200,246
Common brick	980,000	1,313,750
Pressed brick and terra cotta	259,335	105,000
Paving brick	....	42,550
Sewer pipe	....	138,356
Pottery	80,000	101,000
Petroleum products	1,400,435	1,747,352
Natural gas	160,000	440,904
Carbide of calcium	....	74,680
Salt	162,700	317,412
Gypsum	25,980	16,512
Graphite	....	16,179
Talc	....	500
Mica	1,500	38,000
Arsenic	....	4,842
Iron ore	....	30,951
Pig iron	... .	808,157
Nickel	590,902	526.104
Copper	232,135	176,237
Cobalt	3,713	....
Gold	36 900	423,978
Silver	732	65,575
Zinc	....	24,000
Totals	$5,350,349	$8,789,901

The list shows that during the eight years paving brick, sewer pipe, carbide of calcium graphite, talc, arsenic, iron ore, pig iron and zinc have been introduced as new products of the mineral industry, whose aggregate value last year was $1,140,215. Stone and

clay products have increased in value by $1,343,186, petroleum products and natural gas by $627,821, salt by $154,712 and mica by $36,500. A falling off is shown in gypsum, nickel and copper; but in the case of the two metals this result is almost certainly due to a too low estimate of selling prices at the works. There is an increase in gold and silver of $451,921, and of all metalliferous products of $1,195,462. The aggregate increase in the value of products in 1899 over 1892 is $3,439,552, and in 1899 over 1898 it is $1,554,024. Altogether the outlook for the mineral industry of the Province was never so cheering as it is now.

Statistics of metal production for the first half of the current year (1900) afford evidence of continuing progress. Several gold mills have been idle, pending development of the mines, enlargement of machinery capacity and other causes. Returns have been received from eight, which show that during the six months 22,177 tons of ore were treated. The yield was 9,983.37 ounces, worth $156,269.84 gold and $141.54 silver. The silver mines show a product of 12,000 tons ore, with a yield of 85,000 ounces valued at $51,000. The arsenic product was 208,000 lb., worth $8,980. The output of zinc was only 150 tons, estimated at $900. Seven iron mines in the eastern parts of the Province report a yield of 9,608 tons, worth at the selling price at the mines $19,532. One mine in the Michipicoton Mining Division, which began to produce in July, will probably show a larger output than this total for each fortnight until navigation closes. At two blast furnaces there was smelted during the first half of the year 50,538 tons ore and 8,155 tons mill cinder. The proportion of Ontario ore used was a little more than one-fourth of the whole, being 13,252 tons; but the second half of the year will no doubt show better results in this respect. The quantity of pig iron produced was 32,279 tons, the value of which is $511,209, computed at the selling price at the furnaces. Open hearth steel begins for the first time to figure in the metallic industries of the Province. The production for the first six months was 945 tons, valued at $25,515. The quantity of nickel-copper ore raised was 87,808 tons, and the quantity of roasted ore smelted was 100,073 tons, which yielded a matte product of 12,323 tons. The estimated metallic contents of the matte is 1,925 tons nickel valued at $413,771, and 1,784 tons copper valued at $165,968. The total value of metal products for the six months was $1,353,287, or two-thirds as much as for the whole of last year.

A number of amendments have been made to the Mines Act during the Session of the Legislature of 1900, the most important of which are the abandonment of royalties on all ores, a provision to secure the refining of nickel ores in the country, and additional regulations for the health and safety of miners.

MINERAL INDUSTRIES OF ONTARIO

Statistics of 1899

In dealing with the mineral statistics of the Province for the year it is proper to take cognizance of the mining companies organized and the transactions of mining lands, as well as the figures of production, of men employed in the industry and of wages paid for labor. Records of accidents also form an essential part of mining statistics, and the nature and causes of such accidents demand inquiry in the interests alike of employers and employés, beside the purpose they serve in shaping legislation to provide for the health and safety of the men engaged in the industry.

MINING COMPANIES.

In previous reports of the Bureau lists have been published of the mining companies which have been organized in the Province under the provisions of the Joint Stock Companies Act since Confederation. These lists gave the names of all such companies, the dates of their charters, and the amounts of their authorized capital. In the list which follows for 1899 there is given in addition the head office of each company, which will be found useful in any case where communication with the office is desired.

MINING COMPANIES INCORPORATED IN 1899.

Name of Company.	Head Office.	Date.	Capital.
			$
The Allan Gold Reefs Company of Ontario, Limited	Ottawa	16th Mar., 1899	40,000
The Atlin Mining Company of Ontario, Limited	Ottawa	19th May, 1899	400,000
The Agassiz Exploration and Mining Company, Limited	Port Arthur	31st May, 1899	1,000,000
The Atikokan Gold Development Company of Ontario, Limited	Port Arthur	15th June, 1899	1,000,000
The Anglo-American Copper Mining Company of Parry Sound, Limited	Parry Sound	3rd Nov., 1899	3,000,000
The Argenteuil Gold Mining and Milling Company, Limited	Toronto	24th Nov., 1899	999,999
The Boulder Mining Company of Ontario, Limited	Rat Portage	13th April, 1899	2,000,000
The Baltimore Copper and Gold Mining Company, Limited	London	27th May, 1899	250,000
The Black Hawk Gold Mining Company, Limited	Toronto	3rd July, 1899	498,000
The Baine Mining and Exploration Company, Limited	Toronto	31st Aug., 1899	5,000,000
The Buffalo Consolidated Gold Mining Company, Limited	Niagara Falls	13th Sept., 1899	3,000,000
The Bullion Number Two Mining Company, Limited	Rat Portage	22nd Sept., 1899	999,999
The Britannia Consolidated Gold Mining Company of Ontario, Limited	Ottawa	18th Oct., 1899	300,000
The British Colonial Mining and Development Company of Ontario, Limited	Millbridge	27th Oct., 1899	500,000
The Corona Mining Company of Ontario, Limited	Niagara	13th Jan., 1899	190,000
The Copper King Mining Company, Limited	Windsor	24th Mar., 1899	150,000
The Crackerjack Gold Mining Company, Limited	Fort Frances	31st May, 1899	1,000,000
The Cambridge Gold Mining Company of Ontario, Limited	Toronto	13th Sept., 1899	980,000
The Crown Point Mining Company, Limited	Ottawa	4th Oct., 1899	1,000,000
The Canada Nickel Company, Limited	Worthington	3rd Nov., 1899	900,000
The Dalton Gold Mining Company, Limited	Fort William	17th May, 1899	990 000
The Dupont Gold Mining Company, Limited	Ottawa	18th Oct, 1899	1,000,000
The Empire Mining Company of Manitou, Limited	Toronto	10th July, 1899	850,000
The Enniskillen Mining Company, Limited	Sault Ste. Marie	12th Aug., 1899	480,000
The Fighting Chance Gold Mining Company, Limited	Mine Centre	19th April, 1899	999,000
The Gold Reserve Mining Company of Ontario, Limited	Toronto	28th Feb., 1899	99,000

MINING COMPANIES INCORPORATED IN 1899.—*Concluded*

Name of Company.	Head Office.	Date.	Capital.
			$
The Golden Crescent Mining and Exploration Company of Ontario, Limited	Port Arthur	16th Mar., 1899	1,000,000
The Gold Bug Mining Company, Limited	Mine Centre	16th Mar., 1899	1,200,000
The Gold Sun Mining Company, Limited	Windsor	13th April, 1899	250,000
The Golden Eagle Mining and Exploration Company of Ontario, Limited	Mine Centre	13th April, 1899	1,000,000
The Gold Leaf Mining Company of Ontario, Limited	Ottawa	19th April, 1899	900,000
The Galena Gold Mining Company, Limited	Niagara Falls	26th April, 1899	999,000
The Gananoque Gold Mining Company, Limited	Gananoque	25th May, 1899	450,000
The Great North Countrie Gold Mining Company, Limited	Toronto	25th May, 1899	800,000
The Gold Quarry Mining Company, Limited	Cornwall	31st May, 1899	900,000
The Gold Bullion Mining Company of Ontario, Limited	Fort Erie	28th June, 1899	750,000
The Guinea Gold and Copper Mining Company of Toronto, Limited	Toronto	28th June, 1899	999,000
The Gold Panner Mining Company of Ontario, Limited	Rat Portage	19th July, 1899	999,999
The Gold Reefs Company, Limited	Ottawa	28th July, 1899	1,000,000
The Gold Coin Mining Company of Ontario, Limited	Mine Centre	31st Aug., 1899	600,000
The Guelph Mining and Development Company, Limited	Guelph	13th Sept., 1899	999,000
The Glass Reef Gold Mining Company of Lake Manitou, Limited	Wabigoon	21st Oct., 1899	750,000
The Gold Winner Mining Company of Ontario, Limited	Port Arthur	13th Dec., 1899	1,000,000
The Headlight Gold Mining and Exploration Company of Ontario, Limited	Mine Centre	13th April, 1899	1,000,000
The Hornblende Gold Mining and Exploration Company of Ontario, Limited	Toronto	13th April, 1899	900 000
The Hammond-Reef Consolidated Mining Company, Limited	Toronto	23rd June, 1899	5,000,000
The Hartford Gold Mining and Development Company, Limited	Toronto	13th Dec., 1899	300 000
The Island Falls Mines Company, Limited	Port Arthur	12th July, 1899	1,500,000
The Imperial Copper Company of Parry Sound, Limited	Toronto	26th July, 1899	5,000,000
The John Sykes Mining and Milling Company, Limited	Toronto	6th Jan., 1899	499,999
The Kalevala Gold Mining Company, Limited	Mine Centre	17th Dec., 1899	1,000,000
The Mikado Peninsula Gold Mining and Development Company of Ontario, Canada, Limited	Rat Portage	13th April, 1899	100,000
The Mines Contract and Investigation Company, Limited	Toronto	12th May, 1899	100,000
The Montreal-Manitou Mines Company, Limited	Ottawa	6th Oct., 1899	750,000
The Minnesota Ontario Gold Mines Company, Limited	Mine Centre	1st Nov., 1890	2,000,000
The Mount Royal-Manitou Gold Mining Company, Limited	Toronto	24th Nov., 1899	995,000
The Northland Gold Company of Ontario, Limited	Mine Centre	27th Sept., 1899	1,000,000
The National Mines Investment Company, Limited	Toronto	3rd Nov., 1899	1,000,000
The Nickel Copper Company of Ontario, Limited	Hamilton	27th Dec., 1899	1,000 000
The Ontario Victoria Mining Company, Limited	Toronto	28th Feb., 1899	950,000
The Orion Gold Mining Company, Limited	Rat Portage	17th May, 1899	999 999
The Ophir Mines Development Company of Ontario, Limited	Toronto	13th Sept., 1899	1,000,000
The Parry Sound Copper Mining Company, Limited	Parry Sound	23rd Mar., 1899	5,000,000
The Prichard's Harbour Copper Mining and Development Company, Limited	Rat Portage	13th Sept., 1899	500,000
The Quartz Creek Gold Mining Company of Ontario, Limited	Toronto	26th April, 1899	950,000
The Rock Lake Mining Company, Limited	Sault Ste. Marie	18th Jan., 1899	1,000,000
The Randolph Gold Mining Company, Limited	Rat Portage	28th Mar., 1899	1,000,000
The Standard Gold Mining and Development Company of Eagle River, Ontario, Limited	Eagle River	28th Dec., 1899	475,000
The Saint George Mines Development Company, Limited	Toronto	22nd Feb., 1899	150,000
The Standard Mica Company of Toronto, Limited	Toronto	28th Mar., 1899	90 000
The Sudbury Copper and Nickel Company, Limited	Sudbury	3rd May, 1899	2,000,000
The Sirdar Gold Mining Company, Limited	Toronto	3rd June, 1899	1,000,000
The Slocan-Kilo Mining Company, Limited	Ottawa	28th Nov., 1899	7,000,000
The Victor Gold Mining and Development Company of Rat Portage, Limited	Rat Portage	8th Nov., 1899	999,999
Licensed Mining Companies.			
The Canadian Copper Company	Clevland, Ohio	7th June, 1899	2,500,000
The Canadian Mines Development Company of Michipicoton	London, Eng.	13th Dec., 1899	1,458 000
The Great Lakes Copper Company	Boston, Mass.	5th Oct., 1899	3,000,000
The Golden Rod Mining Company	New York	3rd Nov., 1899	100,000
The Manitou Lake Gold Mining Company, Limited	St. Paul, Minn	26th July, 1899	1,000,000
The Northwest Ontario Mining and Development Company, Limited	London, Eng.	16th Sept., 1899	243,000
The Sailor Consolidated Mining and Milling Company of Camp McKenney, Limited	Toronto	6th May, 1899	1,250,000

The total number organized and chartered during the year was 74, with an authorized capital of $87,382,994. But to this number may be added seven other companies organized elsewhere which have taken out licenses to sell stock and other securities, and all but one of which are carrying on mining operations in the Province. The authorized capital of these seven companies is $9 551,000, which with the other companies chartered during the year maké up a total of 81, with an authorized capital of $96,933,-994. The aggregate number of mining companies to which charters and licenses have been issued since Confederation is 416, with an authorized capital of $291,757,372.

MINING LANDS.

The number of mining locations sold and leased by the Crown last year was 790, with a total area of 98,307 acres, and the amount received from sales and rentals was $150,975 02. This sum includes $12,981 11 derived from lands previously leased and which are subject to a yearly rent charge. Adding $4 979 collected as fees in the Michipicoton mining division, the aggregate revenue of the mineral lands of the Province for 1899 is $155,954.02, which exceeds the revenue of 1898 from the same sources by $54,768 40, and the revenue of 1898 exceeded the average of the preceding six years by $51,098.88.

The following table gives the details by districts of mineral lands sold and leased in 1899:

MINING LANDS SOLD.

District.	Sales.	Acres.	$
Rainy River	235	27,472	57.838 25
Thunder Bay	11	1,968	3,456 25
Algoma	18	2,321	7,136 70
Elsewhere	30	3,288	6,936 17
	294	35,049	75,367 12

MINING LANDS LEASED.

District.	Leases.	Acres.	$
Rainy River	320	29,217	29,217 00
Thunder Bay	106	24,034	24,034 00
Algoma	25	3,758	3,758 48
Elsewhere	45	6,249	5,617 31
	496	63,258	62,626 79

MINERAL PRODUCTION.

As shown by the summary table on page 13 the total value of the mineral products of the year was $8,789,901, which is $1,554 024 or 21½ per cent. more than in the preceding year. The number of hands employed was 10,003 and the amount of wages paid for labor was $2 930,100, which in number was 33 per cent. and in amount 19 per cent. more than in 1898. The largest increases are in building materials, pig iron and gold, and the largest decrease in petroleum products. Nickel and copper show less values than

in 1892, although the products were larger and market prices of the metals were higher than in that year.

BUILDING MATERIALS AND CLAY PRODUCTS.

An upward tendency is manifested in the production of building materials. In building materials proper, including stone, brick, lime and cement, the values were $3,556,366 or $1,107,704 more than in 1898. The value of cement rose to $561 266, being $184,948 more than in 1898, and nearly 80 per cent. of the whole was Portland cement. Since 1894, when this cement began to be made in the Province, the production has increased from 30,580 barrels to 222,550 barrels and the value from $61,060 to $444,227, and during this time the value of imports has been steadily increasing. In the last fiscal year it reached 1,300,424 cwt., valued at $467,944, in the face of a duty of $147,145. The value of drain tile, sewer pipe, paving brick and pottery in 1898 was $522,152, or $48,435 more than in the previous year.

PETROLEUM, NATURAL GAS AND CARBIDE.

These three products come under the same general class. The petroleum industry of the country is now practically controlled by one corporation, which is understood to be a branch of the Standard Oil Company. The result of the first year's operations shows a considerable falling off in quantities and values, the crude oil being less than in the previous year by 3,363,010 gallons, and the total value of refined products less by $223,182. But the percentage of illuminating oil distilled from the crude continues to show steady improvement, it having risen from 38.67 p.c. in 1892 to 45.52 in 1898 and to 49.53 p.c. in 1899. The percentage of lubricating oil is more than 4 per cent. less than in 1892 and about the same as in the three years preceding last year. But on the other hand the percentage of all other oils has fallen from the average of the three years to the rate of 1892, being 28.8 per cent. The producing area continues to be about the same as in 1898, and no important new strikes have been reported.

During 1899 there were bored in the two natural gas fields of the Province 35 new wells, 28 of which proved to be producers. The total number of producing wells in the year was 150, being 8 more than in 1898, and the length of pipe for the delivery of gas was 341½ miles, or an increase of 26¼ miles. The number of men employed in the industry was 95, the amount of wages paid for labor was $40,149, and the value of product $440,904. In 1898 the amount of wages was $31,457 and the value of product $301,-599. The companies paid to the Provincial Government last year under the provisions of 62 V. c. 8, an aggregate of $9,362.93.

Two works were producing carbide of calcium last year, but one of them met with an accident and was a producer for part of the year only. The quantity produced therefore only shows a small increase upon the figures of 1898. A new mill is in course of construction at Ottawa, which no doubt will add materially to the extent of the business for the current year.

SALT AND GYPSUM.

The salt industry is expanding steadily, and during the past year it reached a value of $317,412. The twelve works in operation produced 45,347 tons of fine salt, valued at $249,157, and 11,028 tons of coarse salt, valued at $68,255. In 1898 the total product was 59,385 barrels, valued at $278,886, and in 1892 it was 43,387 barrels, valued at $162,700. The recent increase in value is largely due to the fact that at some of the principal works salt of a better quality is being produced. The total number of workmen employed at the 12 salt establishments last year was 261, and the amount of wages paid for labor $80,021.

The gypsum business does not indicate any activity, and the statistics show little or no advance upon previous years.

TALC, GRAPHITE AND MICA.

These three minerals are yet in the very early stage of development. The discovery of a deposit of excellent talc in the vicinity of Madoc has led to the opening up of a mine in that region, for which there is likely to be a good demand. At present the whole of

SUMMARY OF MINERAL PRODUCTION IN 1899.

Product.		Quantity.	Value.	Employees.	Wages.
			$		$
Building stone, rubble, etc		....	1,041,350	1,824	535,000
Cement, natural rock	barrels.	139,487	117,039	510	163,288
Cement, Portland	"	222,550	444,227		
Lime	bushels	4,342,500	535,000	990	200,400
Drain tile	number.	21,027,400	240,246	3,416	630,480
Common brick	"	233,898,000	1,313,750		
Pressed brick and terra cotta	"	10,808,000	105,000	186	59,068
Paving brick	"	5,300,000	42,550		
Sewer pipe		... .	138,356	85	30,351
Pottery		....	101,000	123	39,250
Petroleum	Imperial gal	23,615,967	......	491	214,171
Illuminating oil	"	11,697,910	1,059,485		
Lubricating oil	"	2,087,475	189,294		
Benzine and naptha	"	1,394,530	148,963		
Gas and fuel oils and tar	"	5,410,915	213,544		
Paraffin wax and candles	lb.	2,792,766	136,066		
Natural gas		....	440,904	95	40,149
Carbide of calcium	tons [1]	1,064	74,680	48	23,828
Salt	"	56,375	317,412	261	80,021
Gypsum and products of	"	1,200	16,512	25	9,500
Talc	"	100	500	3	135
Graphite	"	1,220	16,179	20	8,000
Mica	"	266	38,000	81	24,565
Iron ore	"	16,911	30,951	87	16,463
Pig iron	"	64,749	808,157	200	79,869
Nickel	"	2,872	526,104	839	443,879
Copper	"	2,834	176,237		
Zinc	"	1,200	24,000	63	13,636
Arsenic	lb.	113,937	4,842	5	2,250
Gold	oz.	37,727	423,978	611	286,797
Silver	"	105,467	65,575	40	29,000
Totals		....	8,789,901	10,003	2,930,100

[1] Net tons of 2,000 lb.

the output is being shipped to New York State, to be milled there, but it is not unlikely that Canadian capital will be found to operate the mine and prepare the product for market at home.

The graphite mine in Brougham is proving to be a large body and the mineral is of excellent quality. If the claims made by manufacturers of the superior value of graphite as material for the manufacture of inks and varnishes are substantiated by time tests, a new and important use of the mineral will be assigned to it in the arts.

The production of mica last year shows a substantial improvement upon that of the previous year. As an insulator of electricity mica has come extensively into use during recent years, and the demand for it continues active. But the employment of the poorer grades as material for the manufacture of pipe and boiler coverings appears to be destined to give an assured success to the owners of mica mines, as it furnishes them a market for a large portion of product which hitherto was thrown into the dump heaps. The company which was organized in Toronto a few years ago to manufacture boiler covering from scrap mica has now a second factory in operation in Montreal, and experiments conducted by officers of the British navy and by a number of railway companies in Great Britain, Canada and the United States have been so uniformly satisfactory as to leave no doubt of the value of mica as one of the best and cheapest of all non-conductor materials.

IRON ORE AND PIG IRON.

Eight iron mines worked on a moderate scale in the counties of Hastings, Frontenac and Lanark last year yielded 16,911 tons of ore, worth $30,951 at the selling price of ore at the mines. In 1898 the production was 27,409 tons, valued at $48,875. In that year the mines employed 100 men whose aggregate of earnings was $26,700. Last year the number of workmen employed was 87, and the amount of wages paid for labor $16,463. The year 1900, however, will show more hopeful results and very substantial increase of production.

The statistics of pig iron denote satisfactory development since the operations of the first furnace began four years ago. The following figures give the details of the industry for the four years :

Schedule.		1896.	1897.	1898.	1899.
Ore smelted	tons	51,138	37,492	77,023	110,036
Scale and mill cinder	"	5,883	5,350	8.614	10,004
Limestone for flux	"	8 657	9,473	13,799	25,301
Coke for fuel	"	30,348	27,810	50,407	74,403
Pig iron product	"	28.302	24,011	48,253	64.749
Value of product	$	353,780	288,128	530,789	808,157
Wages for labor	"	47,000	40,000	61,476	79,869
Average workmen	No.	125	130	130	200

The quantity of Ontario ore smelted last year was 24,494 tons, or 22 per cent. of the whole. In the previous year it was 20,968 tons, which was 27 per cent. of the whole. The increase in the production of pig iron was 16,496 tons, or 34 per cent. ; but owing to the improved market for iron the increase in value was $277,368, or 52 per cent. There was also an increase of 70 in the average number of workmen employed at the furnaces, and an increase of $18,393 in the amount of wages paid for labor.

After a successful career of four years the Hamilton blast furnace has passed this year into the hands of a new proprietory. The Hamilton Steel and Iron Company was organized on the first of January with a capital of $2,000,000, and took over the plants of the Hamilton Blast Furnace Company and the Ontario Rolling Mill Company, the agreement being that the new company should build a steel plant and mill for rolling steel and operate the blast furnace, the old rolling mill and the nail factory connected with it. The site of the steel mill is east of the blast furnace about 150 yards. Its dimensions are 75 by 200 feet, and the framework is covered with corrugated iron. The plant consists of two open hearth furnaces, constructed of steel and lined with fire brick. As first planned, one was an acid-lined and the other a basic-lined furnace; but a short experience showed that the latter was the best suited for the company's requirements, and both furnaces are now basic-lined. The charges are fed through three doors by an

electric charging machine, and each charge consists of about 15 tons of scrap, pig iron, ore, limestone, ferromanganese, etc. The fuel is supplied by four gas generators, and the capacity of each furnace is 40 to 45 tons of steel per day. An electric movable crane moves materials from any point to any point in the mill, and proves itself to be a very economic arrangement. The rolling mills adjoin the steel mill upon the east, and are under construction.

A. T. Wood, M.P., is president of the new company, O. S. Wilcox is general manager, Robert Hobson is assistant general manager and secretary, and W. A. Child is treasurer.

The Deseronto furnace is excellently situated about half a mile south of the town on the shore of the Bay of Quinte, with ample depth of water for shipping at the end of a short pier. The dimensions of the furnace are: Height, 51′ 3″; diameter at hearth, 5′ 11″; diameter at boshes, 9′ 6″; diameter just below bell, 5′ 6″. The average output is 35 tons per day. The blast is supplied by a blowing engine with 24″x48″ steam cylinder, and 48″ square air cylinder; the downcomer is 40″ diameter, branching into two parts which fire the boilers on the one hand and the hot blast stove on the other. The latter consists of seventy-two V-shaped cast iron pipes 9′ high and 5″x8″ in section; these are so arranged that the burning gas plays over their outer surface while the blast is passing inside; the temperature of the latter is raised to 925°. The blast passes from the blowing engine at a pressure of $2\frac{3}{4}$ lb. per sq. in. to a circular receiver 8′x15′, from which it issues by a 16″ pipe which forks into two branches entering the hot stove. The cast house is 98′x43′ in plan, the hot stove 17′x20′; elevator shed 46′x43′. There are two new boilers and one second hand boiler aggregating 250 h.p.; two pumps, 10″x10″ and 5″x″4x6″ for supply to water jackets, two boiler pumps and other accessories. A 25 h.p. Westinghouse engine drives a Junior Westinghouse dynamo which supplies current for lighting, and a $9\frac{3}{8}$″x12″ engine operates the elevator and crusher.

The ore is wheeled from the stock pile to the crusher house. If fine enough it is shovelled directly into the buckets of a belt conveyer; if too coarse, it is first passed through a Blake crusher and then elevated to the bin in a similar manner. For unloading, a trestle 448 ft. long extends into the lake. The track is 40 ft. above water level, and the extreme height is 77ft. There are three hoists made by McMyler, Cleveland, affording ample facilities for rapid unloading. The track runs from the trestle in a new stockhouse 206′x90′ which will be completed during the summer. A new storehouse for charcoal 78′x23′ in plan has just been built in order that a sufficient stock maybe always on hand.

The furnace shell was built by Marsh & Henthorn, Belleville; the trestle by the Peninsular Bridge Co, Detroit; and the engine, pumps, jackets and some other parts belonged formerly to the Union Iron Co. of Detroit.

The charcoal is supplied by the Standard Chemical Co., whose works are distant about half a mile, and by the use of this fuel an excellent series of grades of pig iron is produced much lower in sulphur than the metal from a furnace using coke.

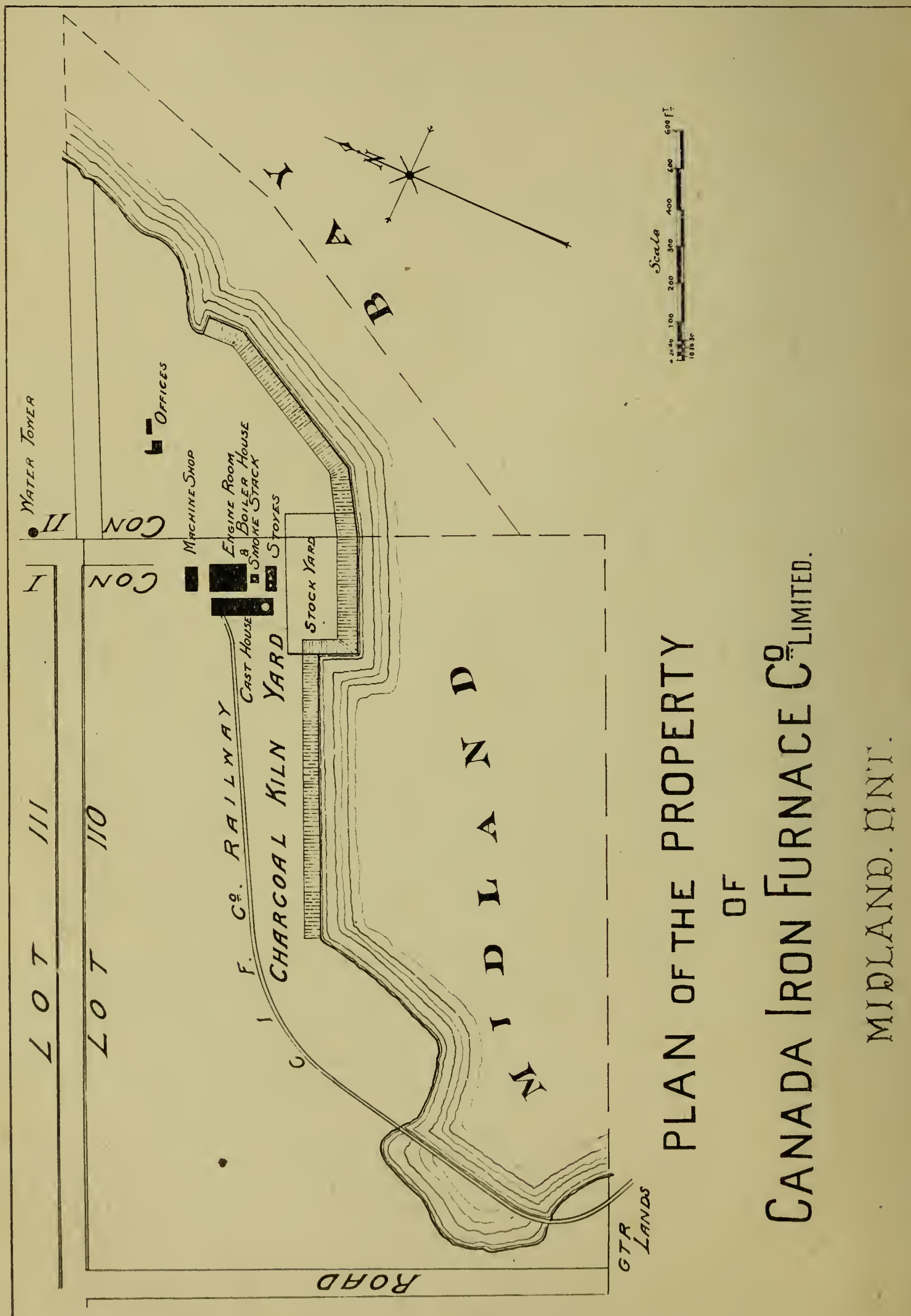
Lake Superior ore has been used chiefly, but during the latter part of 1899 and the beginning of the present year about 600 tons of Canadian ores have been smelted. At present magnetite from the Belmont mine is being used in small quantities, and it is hoped that the output of Ontario ore will increase rapidly to obviate the necessity for importing such large amounts. The remarks of Inspector DeKalb on Iron Mines and Blast Furnaces in his report on the Mines of Eastern Ontario may be read with profit in this connection

Under the provisions of the Mines Act for the encouragement of iron mining, the company will be entitled to a payment from the Provincial Treasurer of fifty cents per ton of pig metal produced from ores not mined in Ontario, and one dollar per ton of pig metal when Ontario ores are used, provided that charcoal fuel is used in the furnace and that the following proportions of Ontario ores are smelted with the foreign ores:

(a) In first period of two years, not less than twenty per cent.
(b) After two years, not less than forty per cent.
(c) After four years, not less than sixty per cent.
(d) After six years, not less than eighty per cent.
(e) After eight years, not less than one hundred per cent.

If the proportion of Ontario ores in any year fall below that specified above, a percentage of the payment corresponding to the percentage of deficiency in Ontario ores wil

be deducted therefrom, and if the percentage of Ontario ores fall below twenty per cent. in any year no payment will be made for the metal produced from ores not mined in Ontario; and of course no claim can be made unless charcoal fuel is used.



A new furnace, in course of erection by the Canada Furnace Company of Montreal, will be blown in during the present year. The location of it is on the northwest side of Midland harbor, at the town of Midland The property consists of about fifty acres, and

1. Canada Iron Furnace Company's Works, Midland, showing Stoves, Smoke Stack, Boiler and Engine Rooms and Machine Shop, pp. 16, 102.

2. Canada Iron Furnace Company's Works, Midland, showing Office, Machine Shop, Engine Room and Cast House, with Smelting Stack and ore and Fuel Elevator, pp. 16, 102.

3. Canada Iron Furnace Company's Works, Midland, showing Machine Shop, Engine Room and Cast House, pp. 16, 102.

4. Canada Iron Furnace Company's Works, Midland, showing Cast House, Elevator and Stoves, pp. 16, 102.

extends 3000 feet along the shore line, where the water will accommodate vessels of twenty feet draft. The buildings consist of a cast house 42′ x 165′, an engine house 40′ x 63′, a boiler house 58′ x 76′ and a machine shop 30′ x 65′. The foundations are of Portland cement and the superstructures of granite and brick. The chimney is a steel stack 8½′ diameter and 170′ above the yard level. It rests on a base of concrete and granite 24½′ square, built to a height of 26′. The furnace stack rests on concrete faced with granite 32′ square at the base and 24′ square at the top. The outside measurement of the stack is 19′ diameter, and it is supported by eight columns of cast iron. Power is supplied by eight boilers of 70 h.p. each, driving two engines, and there are three ovens of 16′ x 60′ to produce hot air for the blast.

The diameter of the furnace stack at the hearth is 8′, at the bosh 13′, and at the throat 10′. The capacity of the crucible is 352 cubic feet and of the bosh 912 feet. The blast is fed through eight tuyeres. The steam cylinders of the blowing engines are 34″ and the air cylinders 72″, with a stroke of 48″. At 35 revolutions the two engines will supply 15,000 cubic feet per minute, and at 40 revolutions they will supply 17,000 cubic feet. This is with allowance for loss, the nominal horsepowers being respectively 616 and 704. The furnace will have a capacity of 150 tons of pig iron per day.

The whole works have been planned by John J. Drummond, the Company's general superintendent, and they are being carried to completion under his direction. The president of the Company is P. H. Griffin of Buffalo, who is one of the largest makers of car wheels in the world. T. Guildford Smith of the same place is vice-president, and George E. Drummond and Thomas J. Drummond of Montreal are respectively managing director and secretary.

At the start of the Midland works the capital stock of the Company will be $500,000 paid up, together with $200,000 of five per cent 20-year gold bonds. Its properties embrace the Radnor Forges enterprise in Quebec, together with timber limits, water powers, limestone quarries and 100,000 acres of bog ore lands in that Province. The sales agents are Drummond, McColl & Co. of Montreal, who, having the benefit of direct connection with the car wheel shops at Hamilton and St. Thomas in Ontario and at Lachine in Quebec, besides being largely interested in the manufacture of cast iron gas and water pipes at Lachine and Londonderry, N. S., are in a position to find a ready market for the output of the new furnace. It is expected that at first the bulk of the supplies of ore will come from Michipicoton.

Two other blast furnaces are projected in the Province, one to be located at Collingwood and the other at Kingston ; but neither of these projects have yet taken substantial shape.

NICKEL AND COPPER.

In the eight years 1892–99, for which complete statistics are available, the quantity of nickel and copper ores smelted and reduced to matte in the Sudbury district was 763,082 tons, and the estimated metallic contents were 36,449,000 lb. nickel and 40,338,500 lb. copper. At the selling price of matte at the furnaces, which is the form in which it is exported to the refineries, the total value of the nickel product in the eight years was $3,295,000 and of the copper $1,480,000, or a total of $4,775,000. But at the average selling price of the metals during the eight years the value of the refined metals would be $12,696,000 for nickel and $4,657,000 for copper, or a total of $17,353,000. The total amount paid for wages in Ontario during the eight years was $2,334,000, and this makes up a large proportion of the expenditure for all purposes in our Province for the production of matte. After allowance is made for the cost of explosives, fuel and other supplies, a large part of the remaining $2,441,000 which makes up the selling value of the matte at the works must be placed to the credit of profits and the bounty of Nature. It is certain therefore according to these statistics that the share of the value of the refined metals distributed outside of Ontario for wages, services and profits during the eight years has not been less than $12,578,000, or 72 per cent. of the whole.

The total quantity of ore raised last year was 203,118 tons, and the total quantity smelted 171,230 tons. The following table gives the statistics for the five years 1895-99, according to the returns made to the Bureau:

Schedule.	1895	1896	1897	1898	1899
Ore raised ....tons	75,439	109,097	93,155	123,920	203,118
Ore smelted .... "	86,546	73,505	96,094	121,924	171,230
Ordinary matte .... "	12,525	9,733	13,706	21,101	19,109
Bessemerized matte "	103½	......	328	......	106
Nickel contents .... "	2,315¾	1,948½	1,999	2,783¾[1]	2,872
Copper contents .... "	2,365½	1,868	2,750	4,186¾	2,834
Value of nickel .... $	404,861	357,000	359,651	514,220	526,104
Value of copper .... "	160,913	130,660	200,067	268,080	176,236
Wages paid .... "	209,960	247,151	253,226	315,501	443,879
Men employed ..number	444	485	535	637	839

With an increase of nearly 50,000 tons in the quantity of ore smelted, the nickel contents in 1899 exceed those of 1898 by less than 100 tons, and the copper contents are actually less by 1350 tons. These figures should be verified before any attempt at comparison is made with them.

The statistics of labor show that there were employed at the mines and works last year underground 278, and above ground 536, with 25 boys under 16 years of age above ground, and that the total amount of wages paid for labor was $443,879.

ARSENIC AND ZINC.

These are two of the most recent additions to the metallic productions of the Province. Arsenic is a content of the mispickel ores of Hastings county, and is one of the bye-products of gold mining. Zinc is found also in the same county, but the largest deposits are on the north shore of lake Superior, where a mine was opened last year.

GOLD AND SILVER.

Gold was produced last year at 15 locations, being two less than in the previous year; but there was a considerable increase in the number of men employed and in the amount of wages paid for labor, as well as in the gold product of the mines. The following table gives the statistics of gold mining in the Province for the last five years:

Schedule.	1895	1896	1897	1898	1899
Mines worked ..number......	8	8	9	17	15
Men above ground "	126	103	222	296	307
Men under ground "	111	86	216	284	356
Ore treated........tons......	6,500	13,292	27,589	57,895	59,615
Gold product..... ..oz.......	3,038	7,154	11,412	16,261	27,594
Gold value............$......	50,781	121,848	190,244	275,078	424,568
Wages paid for labor.. "......	56,234	91,210	217,766	290,919	324,024

A great deal of development work was carried on during the year of which no account is taken in this table, which deals with bullion-producing mines only. It may also be stated that a large proportion of the wages paid for labor is properly a charge against capital, as it has been expended in opening up the mines. But it will be noticed that for the first time in the period of years the value of the gold product exceeds the amount paid for labor.

[1] By a printer's error the nickel contents for 1898 were given as 2,283¾ tons instead of 2,783¾ tons. But there is a strong probability of errors in the returns of nickel and copper contents for the last two years.

The next table gives the statistics of silver mining for the two years 1898 and 1899 :

		1898	1899
Ore raised	tons	6,600	8,000
Ore stamped	"	5,600	8,000
Bullion product	oz.	86,600	105,467
Value of bullion	$	51,960	65,575
Wages paid for labor	"	28,430	29,000
Average workmen above ground	number	32	23
Average workmen underground	"	27	17

Better results may be expected in silver as well as in gold mining as capital is invested and expended for exploration and development work. The experience already gained proves that the Province has important resources in the precious metals.

CORUNDUM.

Prof. Willett G. Miller was unable to do any systematic field work in 1899 on account of his time being taken up in connection with the milling of corundum rock and the preparation of material for the Paris exhibition. An account of the results of the mill work and of the tests on corundum made by a number of manufacturers was added to the last Report. As the results of economic interest were given in that Report it is not necessary to repeat them here. It may be added, however, that all the refined corundum which has been distributed since that time has been found by manufacturers to be of first class quality, and a considerable demand has arisen for the Ontario material. This demand will be supplied in the near future, as the works of the Canada Corundum Company which are being erected in the township of Raglan are nearing completion. The machinery which is being placed in this mill is of the latest and most approved designs, and since a very careful study has been made of the methods of treatment of the Ontario rock it is believed that the plant being erected will be found to be well adapted to the work it is required to do. As the corundum industry is a new one in this country it was necessary to go slowly at first and make a careful study of the subject before erecting a plant. Now, however, it is felt that those in charge of the work have obtained all the information on the subject possible to be acquired, both from experiment and from the experience of other fields, and the district should soon become a steady producer.

During last winter Prof. Miller had the opportunity of visiting the well-known corundum districts in North Carolina and Georgia. Some of these deposits have been worked for a number of years, but at the time of his visit there was little activity in the industry. This was owing chiefly to two causes. The deposits are so situated that the product of the works has to be teamed long distances over mountain roads in order to reach shipping points on the railroad. Moreover, several of the deposits on which considerable work has been done have been found to be of small size and have been abandoned. Only one property has apparently been worked with success, and the easily worked material in this deposit is now about exhausted. Up to the present the product has come chiefly from the decomposed rock matter, but hereafter the output will have to be derived from treatment of the solid rock. A new plant with new method of treatment is necessary to ensure success and to overcome difficulties of transportation.

The Ontario deposits certainly have a considerable advantage over those of the South in respect to cost of transportation. In regard to the quality of the material so far produced from the deposits of this Province there is nothing to be desired. As to their size and the percentage of the mineral in the rock, Prof. Miller says they compare favourably with any deposits which he has examined. Indeed it is doubtful if any of the Southern deposits contain as much material which can be worked at a profit as do some of those of this Province.

The mineral occurs in the South under conditions similar to those under which it is found here, but the rocks in which it there occurs are on the whole considerably more basic.

At the present time it is almost impossible to obtain corundum on the market. There are many cases in which if it were obtainable it would replace emery entirely. In other cases it is in demand for mixing with emery in order to bring up the cutting power of the latter. The demand for high class abrasives is increasing, and is likely to be much greater in the near future.

POSTSCRIPT.

The Canada Corundum Company has been vigorously prosecuting development work of late and a small mill has been erected. The treatment of the corundum rock is still (August, 1900) in an experimental stage, and for that reason no detailed account of the operations is given. However, Mr. J. W. Wells, Assayer at the Provincial Assay Office, Belleville, recently paid a visit to the works and has prepared the following brief sketch of the plant.

The officers of the Company are,—President, Clark Edwards, Bridgeport, Conn; Vice-President, J. N. Shenstone, Toronto; Managing Director, B. A. C. Craig, Toronto; Mine Manager, R. T. Hodgson, B.A., graduate of Kingston School of Mines; Mil Foreman, L. S. Ropes, graduate of Houghton School of Mines, Michigan. There are at present thirty-five men on the pay roll.

The mines owned by the Company now being opened up are situated on the south slope of a hill on a farm owned by Henry Robillard, in the township of Raglan, Renfrew county. The exposure showing corundum in place runs 250 feet north and south, and is about 300 yards wide. Considerable stripping of overlying earth and debris has been done. There are three openings which are being worked by benches, starting from the lowest exposure as in a quarry. About 550 tons of milling rock were on the dumps at the time of visit. The corundum occurs in form massive to crystalline, from the size of a pea to 100-lb. lumps, in a reddish syenite. Hand cobbing is not necessary, as most of the rock taken out is fit for milling, carrying from fifteen to thirty per cent. corundum. The rock is hauled by teams to the mill, three-quarters of a mile distant.

The mill is located on the site of Kelly's saw mill, on a creek flowing into the York branch of the Madawaska river, about seven miles south of Combermere village by the road. The mill dam is fed by three streams and an upper dam, giving fairly good power. Application is being made to the Government to divert the waters of Echo lake, which would give abundance of power. The mill at present is only experimental, the object being to determine the cheapest and easiest method of concentrating the raw material to a marketable product. It treats on an average twelve tons of rock per day of ten hours, giving from one and three-quarters to two and a half tons of concentrates. Water is drawn from the dam by a penstock 15 inches in diameter, 442 feet long, leading to a five-nozzle Leffel Cascade impulse water-wheel, furnishing with a fifty-two foot head of water 35 available horse power. The water-wheel is connected by belting, shafts and wire cable to the main shaft in the mill, 400 feet distant from the wheel.

The rock broken to a convenient size is fed to a large Gates crusher, the crushed rock passing down to large steel rolls. The product from the rolls is elevated to a tilted revolving cylindrical sizer divided into three compartments, (1) $\frac{1}{8}$ inch, leading to concentrating tables below; (2) $\frac{1}{4}$ inch, leading to a two-compartment Hartz jig; (3) $\frac{1}{2}$ inch, leading to a two-compartment Hartz jig. The rejections from the sizer go down to the rolls for re-crushing. The concentrated production from the jigs, freed to a considerable extent from felspar, mica, etc., is re-crushed, washed, dried, freed from magnetite by a magnetic separator and sized by screens to marketable product, containing on the average 99.5 per cent. of corundum. The fines ($\frac{1}{8}$ inch and finer) from the sizer pass to two tables—a Wilfley and a Bartlett—which separate the corundum almost completely from felspar, mica, etc., the magnetite however being retained. The product from the tables is dried, passed through the magnetic separator to free it from magnetite and sized for the market. A Gates crusher is used for crushing concentrates for sizing, and for drying a patent dryer made by the Wm. Hamilton Manufacturing Company, Peterborough.

The marketable product, sized from 16 to 40 mesh to meet demands, has a first-rate abrasive quality, owing to the crushed corundum not breaking along parting planes, thereby having a hackly fracture and rough edges. The product sells at an average price of six cents per pound, with a greater demand than supply, as it is alleged to be superior in every respect to emery, carborundum or any other abrasive on the market used for the same purposes.

The Company has plans prepared for a 100-ton mill to be erected as soon as a satisfactory scheme of concentration is evolved from the experimental plant now in operation.

PEAT FUEL.

Whether coal existed in this Province or not was a question of intense interest to the inhabitants in the early decades of the present century. The growth of coal mining in the States lying immediately to the south aroused the attention of the farmer-settlers on British soil, and the fondest hopes were entertained that vast stores of the precious fuel would be discovered on this side of the line. A scheme for the scientific cxploration of the Province gave rise to the Geological Survey, with a chief who had become famous for his work on a Welsh coal field, and for many years Logan and his faithful staff labored at a herculean task. As time went on, and data were accumulated, it became more and more evident that coal was not to be found in Ontario, although a variety of other minerals in greater or less profusion were discovered at many points.

With the exception of wood, which grows alike in scarcity and price year by year, Ontario must import her supplies of fuel, and only recently has any glimmer of a coming change been seen. Throughout the entire Province there are vast areas of vegetable matter in the first stage of its conversion into coal, and the utilization of this peat is one of the problems which is being vigorously attacked just now. In previous reports of the Bureau the occurrence and uses of peat have been described in detail, and during the past year satisfactory progress has been made towards the inception of a peat fuel industry.

TRENT VALLEY PEAT FUEL CO.

About one and a half miles south of Victoria Road, a station on the Coboconk branch of the Midland Railway, are situated the works of the Trent Valley Peat Fuel Co. For over a year the officers of the company have been experimenting with various forms of apparatus, and have evolved a plant for the conversion of the moist, spongy peat into dry compact briquettes whose calorific value per unit of cost compares favorably with coal.

Peat bogs in the basin of Balsam lake, stretching southeast from the works with an area of 30 square miles and southwest with a similar area, are to be the sources of supply, while large stores to the northeast are available also should the demand arise. The depth of the peat varies from 4 to 55 feet, and the computation of the quantity obtainable leads to enormous figures. The peat is dug out by a dredge handling three cubic yards or 4,050 lb. per minute, and is piled in heaps on the bank for air drying. After two weeks or so, the peat is removed by the dredge to barges which are towed to the works. At this stage water constitutes 80 to 90 per cent. of the whole, and this is lowered to 55 per cent. by a pressure of 300 tons applied to one ton lots of peat at a time. The compact block which results from this operation is thrown into a screw conveyor and broken up roughly in order that it may be handled by a chain conveyor. The latter forwards the peat to the breaker, which consists of a large number of loose arms mounted upon subsidiary axles, in such a manner that when the main shaft is revolved the arms upon the other axles fly out by centrifugal force and beat violently any objects within their reach ; the whole is cased in. The peat is by this means reduced to fibres and powder, and passes to the dryer, which was built by F. D. Cummer & Son, Cleveland. This apparatus consists of a cylinder 30 feet in length, enclosed in a large brickwork chamber, and the following concise description is extracted from the manufacturer's catalogue : "The pure heated gases resulting from perfect combustion of the fuel in the heating grate pass into a large commingling chamber which extends the entire length of the dryer

cylinder. This cylinder (which is set at an incline and revolves slowly in trunnioned bearings) has a great many large hooded openings so arranged that the heated air and gases at highest temperature are drawn through the hoods by a fan into the cylinder in direct contact with the wet material entering the machine. The material immediately commences to part with its moisture, and as it travels rearwards towards the discharge constantly becoming more dry, the temperature of the heated air brought in contact with it is relatively lowered. The drying material is constantly being cascaded in the cylinder." After drying, the peat is conveyed to the compressing house, in which are installed three machines of Dickson's patent. This machine is fully described in the seventh report of the Bureau, page 22.

To make good briquettes the moisture must not exceed 12 per cent. ; if there be more than this, the briquettes crack on drying, and chip readily, while if ignited they burn with a series of small explosions due to the generation of steam. Nor must the moisture be less than 10 per cent, or the friction in the compressing tube becomes so great that the machines would soon be racked to pieces. However, by means of the hydraulic press and with careful attention to the temperature of the drying kiln, it is anticipated that there will be no trouble in the production of a fuel of uniform excellency.

From the machines the briquettes travel by a screw conveyor to the storehouse, where they are sacked and hauled to the railway or shipped in barges by the Trent Valley canal which passes by just beside the works. The company believe that when the works are running to their full capacity the briquettes may be delivered in Toronto at a price which will make them a dangerous competitor for other fuels in the market. With cheap water communication along the canal there is no apparent reason why the briquettes should not be delivered in the towns along the line at such a cost as to displace all other fuels save anthracite.

The officers of the Trent Valley Peat Fuel Co., are : President, A. L. Davis ; Secretary-Treasurer, W. G. Morrow ; Superintendent, W. J. Sims ; the head office is at Peterborough. To Mr. Sims, who is a contractor, chiefly for Government work, is due all the credit for the plant ; his ideas and experience are embodied in the present plant, and many changes have been made under his direction. The company have secured from the Canadian Peat Fuel Co. the rights to operate their machinery in the counties of Ontario, Durham, Victoria, Peterborough, Northumberland, Hastings and Prince Edward. The following buildings have been erected on the site previously mentioned : Drying kiln house 60 x 30 ft.; storehouse for dry peat 100 x 40 ft.; press house 30 x 40 ft.; engine house 24 x 40 ft.; storehouse for briquettes 60 x 30 ft., capacity 200 tons. Power is supplied by a 90 h. p. boiler and a 75 h. p. Wheelock engine, from Goldie and McCulloch.

BEAVERTON PEAT WORKS.

Mr. Alexander Dobson has for some time been operating a plant for the manufacture of peat fuel near Beaverton. The works are situated upon a bog with an area of 150 acres, about a mile and a half south of the town, and a considerable quantity of compressed peat has been produced.

The surface having been stripped, the peat is cut by an automatic digging machine, which is so much superior to manual labor that it merits description. A trench is first cut in the bog, and the machine is placed in position close to the edge ; a short, enclosed link belt carrying knives and scrapers hangs from the machine, and touches the bottom of the trench which is made 8 inches wider for a foot or so at one end. When motion is communicated to the belt, the knives and scrapers cut into and carry up the peat to a hopper, from which it is removed to the other side of the machine by a short chain conveyor. At the same time the supporting wheels of the machine, which are very broad, are driven at slow speed, and the machine moves continuously forward, supplying to the digging apparatus fresh surfaces from which to cut the peat. In this manner the machine moves along the edge of the trench, increasing the width of the latter 8 inches in passing, and by a series of journeys removes all the peat from the area exposed to a depth of 2½ feet. When discharged from the machine the peat is raked out into thin beds and allowed to dry roughly ; it is then shovelled into waggons and drawn to the mill by electric power. The peat must now be more thoroughly dried, and this is done, after a preliminary breaking, in an apparatus which has been patented by Mr. Dobson. It con-

sists of a cylinder made of boiler plate, 5 feet in diameter and 30 feet long, mounted on an axle which dips a little from the horizontal; the cylinder is enclosed in brickwork with a fire-place under the higher end. The lower end is open, and connection is made with the chimney in such a way that when a fire is lighted in the grate the flames strike the outside of the cylinder, almost at its highest point, and play along it until the other end is reached, where the products of combustion pass into the cylinder, and after travelling back over the wet peat, which is fed in at the upper end, escape through the stack. The peat is subjected to two drying influences, the direct heat of the fire and the current of hot dry air which is escaping, so that only a short time is needed for desiccation. The dried material, still retaining 10 or 12 per cent. moisture, is passed through a Dickson breaking machine and then passes to a Dickson press. In a 10-hours day 5 tons of briquettes on an average are turned out by the one machine, and it is probable that some experiments which are being made will result in an increase of the production to 10 or 12 tons per day. Considerable difficulty is experienced with the dies, which often break under the strain, necessitating a costly delay in operations; it is almost certain, however, that this obstacle will be overcome shortly and the whole plant will be worked smoothly and continuously. The briquettes are delivered in Beaverton at $3.25 per ton, in comparison with anthracite at $6.25 per ton, and find ready sale. Those who use the peat consider that it is as good as coal, and prefer to use it because of the absence of smoke and clinker.

In a letter to the Canadian Peat Fuel Co., dated July 16th, 1900, Mr. Dobson makes the following statements:

"Answering your enquiries *re* output of my one machine plant, I can readily manufacture 2,000 lb of peat fuel per hour, using dies 2⅝ in. diameter, (with chilled eccentrics now being furnished and heavier dies I anticipate no difficulty in operating continuously). To run my plant I employ eight men at a cost of $9.30 per day of ten hours. This includes the cutting of peat by one man to fire the boiler and drier, (one man can cut in a single day enough crude peat for firing purposes to last several days.) *Re* cost of production: There is no question but that I can produce the fuel, provided the plant is operated continuously, under $1.00 per ton. I would recommend operating night and day, and after improvements to press are completed I propose to keep my plant running day and night. The cost of production will thereby be appreciably reduced. *Re* Drier: Working upon peat carrying from 40 to 50 p.c. of moisture my drier easily delivers enough suitably dried peat for one press. Two cylinders can readily be operated in one furnace, delivering two tons of dried peat per hour. Cost of installation would be about $1,700. The dryer is simple in construction, very durable and is easily operated by one man. *Re* Electrical Digger: A simple, strongly constructed plant costs less than $500, digs enough peat in one day to supply one press three days. *Re* Sale: There is no difficulty in finding a ready market; even in this vicinity where wood is freely used I get $3 per ton at works and my customers think highly of the fuel. My plant can be duplicated for $8,000, and I am convinced that wherever a bog adjacent to a town is to be had a highly profitable return can be depended upon under proper business management."

Shortly after this letter was written Mr. Dobson was unfortunately burnt out, and it will be some time before the plant can be repaired and started afresh.

OTHER PEAT COMPANIES.

The following individuals or companies are also commencing to manufacture peat fuel, or have already done so:

The Simcoe Peat Fuel Co., Barrie, with one Dickson press and breaker and Dobson dryer. A peat bog about two miles from the town will be the source of supply.

The Brockville Peat Fuel Co., who are just about to start operations.

Mr. Hogg, at Galt, has already made 200 tons and has sold the entire output at $4 per ton.

The Welland Peat Fuel Co. have made 200 tons this year and are re-commencing after a delay caused by an accident to the machinery.

Mr. Ardagh, at Stratford, has made 250 tons this year and sells the fuel in the town at $4 per ton.

Mr. Matheson, at Perth, with one machine has made some fuel, but has recently formed a company which will take over the business.

A company has also been formed at Chatham and the plant is being installed.

The Prince Edward Peat Fuel Co., at Picton, have two Dickson machines, but have to wait until a dryer is installed before satisfactory progress can be made.

From these notes it will be evident that the peat fuel industry is rapidly taking root in Ontario, and before long we may expect to see the little round briquettes making their appearance beside the time-honored coal and wood. This subject is of so much importance that Inspector De Kalb is preparing a special report dealing with the industry, which will be issued by the Bureau as soon as it can be prepared.

MINING ACCIDENTS.

The past year has been notable, among other things, for the number of serious accidents which have taken place, and it is a matter of the deepest regret that the deaths of fourteen men and injuries to eleven must be reported. While two of the fatal accidents may more properly be ascribed to the operation of a railroad than to a mine, ten of the remaining twelve cases are most distinctly due to the dangerous nature of mining when precautions have not been taken and carelessness has not been checked. Five of the deaths and two of the injuries have been caused by explosives, and this feature has become so serious that a Manual of Explosives, describing their nature, proper use and the precautions which should be employed, has been drawn up under the direction of the Bureau by Inspector DeKalb for the use of those engaged in mining.

Another prolific source of accident has been the misuse or failure of hoisting apparatus; four men have been killed and five injured by mishaps of this nature. This has led to a revision of those sections of the Mines Act which deal with hoisting, and a set of stringent regulations has been drawn up which will certainly reduce the risk very much.

In one instance a man was killed by the rolling of a large piece of ore which had been pointed out to him several times as dangerous, and in this case the blame must be laid entirely on the victim himself. Such an accident might readily occur in almost any excavation above ground, and it can hardly be said that the working of a mine is responsible for such mishaps as this.

In another instance a man was so severely injured by the collapse of a derrick that he afterwards died; and this again can hardly be laid to the account of mining operations. The following are the particulars of the casualties:

AT THE CANADIAN COPPER COMPANY'S MINES.

Six casualties occurred at Copper Cliff during the year, and three of the victims died from the injuries they received.

The first accident of the year took place on the 7th of March, at the rock house of the McArthur No. 2 mine. The cars which convey the ore to the roast yard are placed beneath chutes in the rock house, and are moved by means of crow bars in order that the material may be distributed over the body of the car. Occasionally there is a jam in the chute, and it is necessary to mount the car and loosen the mass with a crowbar. On the 7th of March such a jam took place and one of the men, F. Dido, started to climb up on top of the car. Unfortunately, instead of mounting at the end, as is customary, he chose the side; and as the car was at that moment in motion he was caught between the posts of the rock house and the side of the car and severely crushed. He was taken to the Sudbury General Hospital, and at first it was thought that his injuries were not serious. On the 8th, however, it became apparent that this estimate of his condition was amiss, and becoming rapidly worse he died at 10.30 a.m. on the 10th.

The accident was so obviously due to the carelessness of the deceased that it was not considered necessary to hold an inquest. The danger to which a man is exposed while engaged in such work is certainly not greater than that which confronts the brakeman in railroad work, and the company can be entirely exonerated from blame.

On the 30th of March an accident happened to Peter Flemming, an employee of D. L. McKinnon, roastyard contractor for the Canadian Copper Co. The man was working on the almost perpendicular face of a bed of roasted ore at a short distance from

the ground, and had been endeavoring to dislodge a large mass. Before effecting this he came down and went to work beneath it at the bottom of the heap until the mass suddenly gave way, and rolling down, knocked him over and broke his leg. He was taken to the hospital and after a short time was able to be about again. No blast was fired which would loosen the ore, and the affair can only be regarded as one of those unfortunate occurrences due to carelessness.

On the 5th of April E. Pelletier, another employee of D. L. McKinnon, was injured at Copper Cliff by a blast. Pelletier was working on the roast heaps, and having three holes ready in his pile asked permission to fire one of them. This was granted, and the warning whistles were given by the blaster; Pelletier lit the fuse and went off for some distance. His working-mate testifies that he saw the victim go back to the hole and for unassigned reason shove a piece of wood into it. As he was doing this the explosion took place, and the hand which held the wood was badly torn and some of the bones fractured, but amputation was not considered necessary. This accident was evidently due entirely to the foolhardiness of the man himself.

On April 22nd James Davis was severely wounded while working on a derrick at the McArthur No. 1 mine. A derrick was being erected beside an open pit, and Davis was aloft on the structure when it collapsed, throwing him over the edge of the pit to a depth of 25 feet. He was picked up unconscious, and gradually sank until on the 28th of the same month he died. An inquest was held by Coronor McMurchy of North Bay, and the jury found "that the said James Davis came to his death by the falling of the derrick at McArthur No. 1 mine and then falling into the shaft of the said mine on April 22nd, 1899, said accident being caused by neglect of the Canadian Copper Company, through their foreman, Hugh Dickson, in not having derrick properly guyed, and also in not providing spirit level so that plumbing could be done at bottom of mast."

On the 6th of June a man named Isaac Domanski was knocked down and killed by a train on the property of the Canadian Copper Co. He was on his way from home to the Copper Cliff post office and was walking along the track. A train of ore cars manned by Contractor McKinnon's men overtook him, and the two brakemen made every effort to warn him of his danger; but he seemed to be perplexed and confused, and stepping in the wrong direction was knocked down and instantly killed. Notices were posted nearby forbidding persons from walking on the track in that vicinity. Coroner McMurchy of North Bay visited the scene of the accident, and after watching the operation of the cars did not consider it necessary to hold an inquest.

An employe of the Canadian Copper Co., Samuel Lafthi by name, was injured on the 29th of July while going up out of a shaft, which was being sunk. The victim was climbing a ladder at the time, and slipping on a rung fell to the bottom. One of his legs was broken in two places, and there was a fracture at the base of the skull which caused some anxiety. On the 5th of August the man was reported to be doing nicely, and no serious results had followed from the scalp wounds.

AT THE MILLER MINE.

At the Miller iron mine, Hastings, operated by L. Sherk, Son & Co., Hamilton, William Gordaneer was injured in the latter part of March by falling some 30 feet down a shaft. He was engaged in dumping the bucket at the time, and caught his mitten on the hook from which the bucket is hung. He was dragged over the mouth of the shaft, and fell to the bottom about 30 feet, fracturing his leg. The shaft, apparently, was not fenced at the time, and if a proper railing had been provided the accident would probably not have occurred. The use of a proper subsidiary landing hook together with a fencing about the shaft renders the operation of landing no more dangerous than any other carried on in the mine.

AT LOCATION NT 20.

A fatal accident occurred at N T 20, near Shoal lake in the New Klondike district, on March 28th, when James McMahon was killed by a premature blast. Inspector Bow was directed to visit the mine and hold an investigation; and the following evidence was taken by him under oath. The witnesses were William Blouquest and James White, miners who worked with the deceased, Joseph Talbot, who was running the hoist, and

Charles Wright, manager of the mine. The shaft had been sunk vertically to a depth of 80 feet, and William Blouquest, James White and the deceased were working in the bottom of the shaft, hand drilling, on the night of the 27th-28th of March. About 2:30 a.m. on the 28th three holes had been completed and the deceased, who was foreman of the work, ordered the other men to go up while he remained below to charge the holes. The two men were hoisted to the surface in the bucket, and the latter was sent down again for the drills, etc. When these had been brought up eight sticks of powder, sufficient for the three holes, were sent down together with caps and fuse. After fifteen or twenty minutes, ample time to permit of the charging of the holes, the battery wires were lowered, each of the two men who came up handling one wire. These were not connected with the battery in any way, which at this time was in its own box in the engine house; no one but the deceased ever handled the battery or removed it from the box mentioned. It was quite dark at the time and those on the surface could not see whether the charging of the holes had been completed or or not, but sufficient time for connecting the wires had scarcely elapsed before one of the holes exploded. Just a moment before James White had shouted down asking if the wires were long enough, and the deceased answered what they thought was intended for "all right," the latter word being drowned by the report.

The unfortunate man was found dead, with his face badly bruised, the side of his head crushed evidently by flying rock, his legs broken and with other injuries which showed that, in all probability, he was stooping over the hole working at it when the blast went off. The manager stated that none of the powder on the property was over a month old, and the evidence of the other witnesses pointed to the conclusion that it was in proper condition. It was kept beyond the reach of water in the storehouse, and hence could not have got wet; no premature blast or accidental explosion had ever occurred before on the property. The eight sticks used in charging the holes had been thawed out in the engine room before being sent down. The evidence of the two witnesses who had ever done any charging in the shaft, or had ever seen it done, was to the effect that the manager had cautioned them against the use of iron or steel, and only wooden tamping rods had ever been used.

At the time of the accident only two articles were in the shaft which could have been used for tamping; these were a wooden tamping rod and a small pump. The latter consisted of an iron pipe about 3 feet long and 1 in. in diameter provided with a piston inside, and was used for cleaning out holes previous to charging. When the pump was examined after the accident it was found that the lower end was slightly bruised and also slightly bent. This led the manager to the belief that the deceased had used it for tamping, and that it had been shot out by the blast. The Inspector, however, and with him another witness, was of the opinion that the bruising was simply due to ordinary wear and tear. Of the tamping rod only the upper half could be found, indicating in all probability that the stick had been in the hole at the time of the explosion and the lower half had been blown away.

The manager's explanation is that the deceased was probably inserting a stick at a time, and on account of irregularities in the hole had to use some instrument as a rammer. The pressure would probably squeeze some of the nitroglycerine from the absorbent, and if the pump had been used a spark might readily have been produced which would do the mischief.

The Inspector reports that although it was impossible to arrive at a satisfactory conclusion as to the exact cause of the premature blast, the evidence went to show that it was undoubtedly the fault of the victim, probably through carelessness in charging the hole.

AT LOCATION S V 129.

One of the most serious accidents in the year took place on the 18th of May, on the location SV 129 in the Manitou district. Three men, the night shift in this case, were killed instantly by the explosion of a hole which was supposed to have been fired. Inspector Bow, who was then at Bonheur, was instructed by wire to proceed to the scene of the disaster and make an investigation under oath. This was done, and a full report was forwarded to the Bureau.

Five witnesses were examined, Thomas Armstrong, James Maxwell, Samuel Morrey, William Quirk and William James Spedding.

The property consists of location 129 SV belonging to the Oxford Mining Co., head office, 80 Bay St., Toronto, and at the time of the accident a shaft had been sunk to a depth of about 40 feet. Work was being carried on day and night, with three men in each shift; the drilling was being done by hand.

The details of the accident are as follows: On Wednesday, the 17th of May, the day shift consisting of William Quirk, Samuel Morrey and William J. Spedding had drilled five holes to an average depth of 3 feet; these were being put in for the purpose of squaring up the shaft. At the end of the day Spedding and Morrey went up to the surface removing all tools, etc., while Quirk remained below to prepare for blasting. The five holes were charged with 60 per cent. powder and tamped with a little clay after the insertion of the fuses; the latter were of such length that the holes would be fired in succession. Quirk then came up and the three miners remained close by until they heard the blasts. There were only two reports, indicating that three holes had missed, so Quirk went below again and found that the fuses had not burned properly. He then took out the caps and fuses and inserted an "exploder" in one hole, together with a little extra dynamite, and coming up fired the hole with the battery. Again he went down, and this time arranged that the two remaining holes should be exploded simultaneously. One of these, however, was near the hanging wall, and the water running down was carrying a certain amount of sand into the hole on top of the powder and tamping; part of the latter was removed, but not all. Quirk was a little doubtful as to this hole, but came up and fired the holes with the battery. A report was heard and the men went off to dinner without waiting to ascertain whether both charges had been exploded or not, but believing that the former was the case.

The night shift, consisting of Cornelius Quirk, Joseph Laurin and Bud Irish, went up to work as usual, accompanied by the manager, Thomas Armstrong, who was going to help as was his custom in cleaning out the broken rock. William Quirk went up to the shaft again to see whether all the holes had broken, and calling to his brother Cornelius, who was below, he asked if the corner hole (pointing to it) had broken. Cornelius answered "Not very well," and William then warned him to be careful since some powder still remained in it. Armstrong, the manager, who was there also, told Cornelius Quirk that if he had any doubt about the hole to leave it until morning, and then when charging the other holes to insert a small extra charge and fire it with the rest. Armstrong and William Quirk then went down to the camp leaving no one but the three miners at the shaft, the blacksmith working by day only. At midnight the night shift were down to the camp for supper as usual, and the manager spoke to Cornelius Quirk; this was the last time any of them were seen alive.

In the morning the men went up to work at the usual time about 7 o'clock, the blacksmith being about five minutes ahead of the others. When he reached the shaft he found the lighted lantern hanging on the crank of the windlass, and pulling away the canvas covering which was used to keep out rain, he looked down and saw the men lying in the bottom. He ran back calling for help and met the others on their way up. James Price and Samuel Morrey went down at once and put the bodies into the bucket. The three men were perfectly dead, and must have been killed instantly. A drill 30 in. long was found stuck firmly point first in the collar of the shaft, with a piece broken from the head; it had probably been used for the drilling and had been blown against the side of the shaft which it struck with a force sufficient to cause a break, and then glancing off entered the wooden collar. On one of the bodies was a broken watch which had stopped at 2.57 a.m. The night shift blast from about 5.30 to 6 a.m. and their shots are always heard at the camp, but no report had been noticed by anyone during the night. There can be little doubt that the accident took place at the time indicated by the watch. All the drills and tools were still in the shaft, and it was very unlikely that before these had been removed any powder and fuse would be taken down; as a matter of fact none was to be found.

The positions of the bodies and the wounds that they bore pointed to only one conclusion. The three were drilling either so close to the missed hole that they unexpectedly broke into it, or their hole was so near to the dynamite that the blows were sufficient to cause an explosion. According to the evidence previously stated the men had sufficient

warning about the unexploded charge, and if cautious would probably have avoided it, although they might have thought that all the charges had gone off completely and for that reason taken the risk.

As no one living was down the shaft from the time of the firing of the day shift holes until after the accident, there is no possible way of obtaining evidence as to whether the night shift had reason to believe that any powder remained in any of the holes or not; the victims were good miners, two of them having had a number of years experience, and they should have been fully aware of any risks that they ran.

From the evidence it is clear that the men were carefully warned and that the responsibility rested upon themselves alone. It is often an easy matter to point out how an accident might have been prevented after it has occurred, and in this case two courses might have been taken. Had the last two holes been fired separately, if that were not disadvantageous under the circumstances, it would have been noticed that one of the holes had missed again and proper precautions could have been taken. Or if Wm. Quirk had gone down again after the blast had taken place, he would have discovered that the entire charge in one hole had not exploded. It is evident that when a number of holes are fired simultaneously there should be an inspection afterwards by some competent person.

An accident which bears a strong resemblance to the one described above is mentioned by A. H. Stokes, H. M. Inspector of Mines for the Midland District, Eng., in his report for 1899; the description is quoted in full. "A stone heading was being driven, and a shot of 5 oz. of bellite had missed fire. After an interval of 25 hours, the workmen commenced to bore another hole about nine inches from the missed shot. They were using a machine and screw-auger drill, and when it had bored about three feet the mis-fire shot exploded and injured two men. Upon examination of the stone after the accident it was clearly seen how the accident occurred; for instead of the second hole being drilled parallel to the hole of the missed shot, it was driven at an angle pointing towards the explosive in the missed-fire cartridge, and the screw of the drill had struck the cartridge at a point where the detonator lay, and thus fired the shot. This accident shows not only the importance of starting a shot hole as far as possible from a missed shot, but that its direction should be carefully noted, and be at a point increasing the distance between them rather than approaching the explosive at the back of the first shot-hole."

A slight accident occurred in the early part of June at the same location. James Price was overcome by gas, and while being hoisted in the bucket became unconscious and fell out. He was bruised and received a scalp wound, but his injuries were not serious and he quickly recovered.

AT THE REGINA MINE.

On the 1st of June a miner, Harry Lampshire by name, was killed by falling thirty-five feet down the shaft of the Regina mine. Inspector Bow visited the mine shortly after the accident, but on inquiring into the circumstances did not consider it necessary to hold an investigation. The shaft was being sunk by day and night shifts, and at the time of the accident only two men were at work in the mine, Henry Lampshire and Fred. Harris. It was between three and four p.m., and the men had hoisted the tools from the bottom of the shaft to the platform of the seventh level, thirty-five feet above. Lampshire was at the hoisting compartment at the seventh level and was lowering a rope to Harris at the bottom, when suddenly he fell and was instantly killed. Harris had no idea as to what made Lampshire fall, and there was no one else in the mine at the time. The platform at the level in question consisted of heavy six-inch timbers spiked down with an opening for the hoisting compartment. On top of this heavy round timbers had been piled, and these were held by struts to prevent the platform from being blown away. Consequently the footing was not very good, but such a condition is almost unavoidable where the platform is not far above the blast. The deceased was probably careless in moving about, and tripped or fell over some obstacle.

AT THE BLACK STURGEON MINE.

On June 19th three men, Charles Adams, John Howe and Charles Hass, were killed a the Black Sturgeon mine near Rat Portage through the failure of the hoisting apparatus

About five or ten minutes past seven p.m. four miners got into the bucket to be lowered to the bottom of the shaft. The engineer was standing some twelve feet away from the hoist at the time, and turned around when the signal to lower was given to find that the cable was paying out very fast instead of remaining quiet. He quickly put on the brake as powerfully as possible, and stopped the bucket when it had reached a depth of 120 feet. The shaft is vertical for the first sixty or seventy feet, inclined for the next forty or fifty feet, and then vertical to the bottom at a depth of 175 feet. The bucket in descending so rapidly struck the skids with considerable force and was dashed against the hanging wall, throwing the men off the bucket. Three fell to the bottom of the shaft but the fourth, Anderson, struck the skids, and slipping down them for some distance fell into the bucket again and was saved.

Inspector Bow visited the mine on the 22nd and 23rd of June, and made an investigation under oath into the circumstances of the accident. The following witnesses were examined: Patrick Culligan, manager of the mine and part owner of the property; George Robert Thurber, foreman of the mine; Edward Lindall, head engineer; James McMullen, second engineer; John Linton, lander; Charles John Anderson, who was hurt in the accident, and Oliver Longchamps and Alex. Phillips, miners on day shift at the time. The mine was at the same time examined and the machinery tested. The mine is situated on lot 11, concession 6, of the township of Haycock, and is owned and operated by Messrs. P. Culligan and F. W. Gilchrist. A shaft 6x11 feet had been sunk to a depth of 175 feet, and deviates from the vertical for from forty to fifty feet as has been already described. A ladderway with platforms constructed according to the Mines Act had been provided as far as the first level, which was at a depth of ninety-three feet, and below this ladders were suspended to within twenty feet or thereabouts of the bottom. The lower ladderway was not provided with platforms, nor were the ladders set at suitable angles, but it is not customary or convenient to have this arrangement for the first fifty or sixty feet from the bottom or below the lowest level because of the destructive effects of the blasting. According to the evidence in this case the lower ladders had not been replaced as they should have been, and it was necessary to use the bucket to reach the bottom of the shaft. A pole skidway was provided for the bucket in the inclined portion of the shaft.

The hoisting machinery consisted of a 7x10 in. duplex Ledgerwood hoist with driving pinion, friction clutch and band brake, a 7-8 in. steel wire cable and a steel bucket of half a ton capacity; the engine house was situated about fifty feet from the shaft. Ten men were employed in the shaft, five on each shift, working by contract. No orders to the contrary having been given, the men were always in the habit of riding in the bucket, and as many as three or four sometimes went down at once.

On the day of the accident, about 7.05 or 7.10 p.m., three miners of the night shift were standing on the edge of the bucket holding the rope and waiting to be lowered to the bottom. The bucket was hanging in the open mouth of the shaft, the top level with the floor. Charles Anderson, a fourth miner, told the lander to ring four bells, which was the signal for the engineer to lower men. The bell was rung, but how many times is uncertain from the evidence. Anderson was just stepping on the bucket when it started to descend with the four men on board, slowly at first, and suddenly with great speed. It was evident to those above that the bucket had run away, but it could not be stopped until it had reached a depth of 120 or 130 feet. George Thurber went down by ladder and found the bucket on the skids with Anderson in it still conscious, while the other three men were discovered at the bottom of the shaft dead. They had evidently been thrown from their positions when the bucket struck the skidway, and Anderson escaped almost miraculously in the manner described.

During this time the following incidents had occurred in the hoist house. The engineer, James McMullen, who had just gone on duty half an hour before, was the only one in the engine room at the time. He was standing at the door facing the shaft house and about 12 ft. from the hoist, when he heard the signal bell. Turning immediatedly, he saw that the drum was revolving, and knowing that something was wrong stopped it as quickly as possible by pressing his foot on the brake, applying in all probability at the same time the friction clutch. The brake lever had a play of about 6 in. between two uprights fastened to the floor; these were provided with nine holes each in which a pin could be inserted, so that if the brake were applied and it was desired to keep it in that

condition, the pin could be run through the hole above to lock it down. The Inspector found that the only hole that could be used was the sixth; those above left the brake too slack, while the others below could not be reached. He also ascertained that with the pin in sixth hole the brake alone would not even hold an empty bucket. This improper state of affairs had existed previous to and at the time of the occurrence of the accident. The brake should have been tightened by the adjusting screw so that when the lever was secured in place by the pin it would without the aid of the friction clutch have held the bucket loaded to full capacity. Had such been the case the accident would probably not have occurred. The Inspector also found that with the brake lever fastened at the sixth hole and the friction clutch applied tightly, the bucket could be held when full of rock with six men standing on the rim. The day engineer, when he went off duty at 6.20 p. m. on the day of the accident, left the brake lever with the pin in the sixth hole and the friction clutch on as was customary. This should have withstood much more than the strain to which it had been subjected as shown by the result of the experiment just quoted. The night engineer however, although he did not touch the brake lever, ran the engine for a short time when he came on duty to clear the water out of the cylinders, and to do this without moving the drum it was necessary to throw off the friction clutch. While doing this he would be compelled to press his foot on the brake in order to hold the bucket.

It was also found that when the brake was off altogether and friction clutch applied and held tightly, a certain weight in the bucket would reverse the engine, as would naturally be expected; but if the clutch lever were not held in position by the engineer the revolution of the drum would throw it upwards in such a way as to release the friction clutch, leaving the drum free to run away. When the clutch lever was applied tightly it was almost horizontal in position, and it was discovered that if the lever were raised through 30 or 40 degrees and the brake was applied the drum could not be held but would gradually gather speed.

The probable cause of the accident may now be explained as follows: The night engineer, when he came on, released the friction clutch and ran the engine for a short time as has been previously stated. When re-applying the friction he probably did not shove the lever down until it was horizontal, but left it at an angle of from 20 to 30 degrees from where it should have been. The brake as has been stated was left on by the day engineer, and had not been touched at all. Under these circumstances, from the last experiment made by the Inspector, it would appear that three men could be held, but when a fourth got on the drum was started with considerable resistance at first until the clutch was thrown off, and it was then free to run away restrained only by the feeble brake. The blame for the accident could hardly be placed upon any one man. The manager should not have allowed riding in the bucket, and the men should have used the ladderway to the first level at least. The foreman should have seen that the bottom ladders were replaced after blasting so that recourse to the bucket should not have been necessary. The head engineer should have seen to the proper adjustment of the brake, especially as men were being raised and lowered.

AT THE GOLDEN STAR MINE.

During the year four accidents occurred at this mine, one of which resulted fatally. On August 17th a machine runner, James McAuley, was struck by a piece of falling rock while engaged in sinking the shaft. The victim was working in the sump when a small piece of rock fell from the manhole at the level above, and struck him in the head, inflicting a scalp wound fortunately not serious and a severe cut on the hand, at the same time breaking a finger. On the 19th of September he was reported as quite recovered from his injuries. An accident such as this can only be avoided by caution on the part of workmen themselves, and due care that their actions shall not endanger others. Those who were working at the platform above by accident kicked a piece of rock down the manhole of the ladderway, and probably would never have noticed it had their attention not been called.

On Dec. 8th a timberman, Albert Green, was injured while working in the shaft. He was engaged in erecting a ladder with the purpose of cutting a hitch for the reception of timber about 12 ft. above the sixth level, when he lost his baance and fell 30 feet to the bottom of the shaft, sustaining a severe scalp wound and bruises about the left

shoulder and arm. Fortunately his fall was broken by the skids which lie here at an angle of 70 degrees, so that he slid for the first 20 ft. instead of falling the entire distance. On the fourth of January the manager reported that he had entirely recovered.

On Dec. 11th a machine helper named William Mitchell, while erecting a drill on a stoping bar, accidentally fell a distance of 4 ft. and broke his leg halfway between the knee and the ankle. On Jan. 4th, 1900, he was reported to be doing nicely, and it was expected that he would shortly be about on crutches.

On the 22nd of December R. L. Burnet lost his life in the third level north. The deceased was engaged in shovelling rock into a chute by which the broken ore was discharged into cars on the level below. While thus occupied he undermined a large piece of quartz which was partly embedded in the loose stuff, intending to jump aside when it rolled down. Charles Kellog, who was working with him, spoke several times of the danger of taking too much from beneath the mass, but Burnet paid no attention. Finally the rock broke loose and although Kellog saw it coming and shouted to Burnet, the latter had not time to escape and was instantly killed.

AT THE CAMERON MINE.

By the explosion of some dynamite one man was killed and another severely wounded at the Cameron mine, North Hastings. This mine belongs to the Colonial Copper Co., 32 Broadway New York, and lies about 16 miles northwest from Coe Hill. Inspector De Kalb was instructed to visit the ground and investigate; he reported the following details of the affair: On the 21st of Oct. about 4 p. m. Peter Weese, a miner, and William Galbraith, foreman, were thawing dynamite at the fire in the forge of the blacksmith shop. Mr. Galbraith testified that he and Peter Weese had each a cartridge warming them near the blaze of the fire, while five cartridges were laid to one side in the blacksmith shop. Mr. Galbraith observed that the cartridges were not thawing properly, and had just said to Weese that they had better stop and " put them in the hole," when the explosion occurred. Mr. Galbraith believed that his cartridge had exploded first.

Mr. Galbraith is a native of St. Celestin near Three Rivers, Quebec, but is now a resident of Chalmer, Mass. He is 52 years of age and has been engaged in mining ever since he was 14 years old. He stated that he was quite familiar with hot water thawers, but had been deterred from procuring one for two reasons. In the first place, he had received stringent orders to reduce all expenses as much as possible, although he still had liberty to purchase anything which was urgently required. In addition to this he was expecting that work would cease very shortly, and on that account he was loathe to add to the equipment. It was only during the last two or three weeks that there had been any trouble with the powder, and previous to that he had thawed it simply by the heat of the sun. He had no idea that it was dangerous to thaw dynamite before a fire, and had never had a man injured before while working for him. He had always tried to be as careful as possible of his men and himself in so far as his knowledge extended.

William Daniels was just leaving the blacksmith shop at the time of the accident, and was the only other witness of the affair. His account corroborates that of Mr. Galbraith in all essential details. He states that Peter Weese held two cartridges instead of one, and that he saw the wrapper on the one Mr. Galbraith held take fire. It then went out and he admonished the men to be more careful. Then he saw it take fire again and started to leave the shop. Just as he reached the door the explosion took place and he was hurled 25 ft, but suffered no serious injury. Weese, who was instantly killed, was horribly mutilated, while Mr. Galbraith had one eye blown out, the other blinded, and his hands were so severely lacerated that they had to be amputated.

The saddest feature about this unfortunate occurrence is that it was due entirely to the ignorance of the foreman, who should certainly after the experience of so many years have known better than to thaw dynamite before an open fire. The opportunities which he must have had for learning the danger of this procedure were undoubtedly numerous, and it is almost incredible that he had not some idea of the risk incurred.

AT THE MIKADO MINE.

On Nov. 3rd Oscar Anderson, a miner, was injured while riding in the cage at the Mikado mine. Inspector Bow paid a visit to the mine and and reported the following details of the accident.

It occurred in the main shaft, which is vertical and 250 ft. deep. Timber sets are provided at intervals of 6 or 7 ft. and a cage is used for hoisting. At 11.30 a.m., on the day of the disaster, drills were being sent to the surface in the cage. The shorter ones were lying across the floor, the length of some of them being but very little less than the width of the cage, while the longer ones were standing on end and leaning against the side of the cage. Four miners, one of whom was Anderson, were riding up at the time, one standing in each corner of the cage. There was but very little space, sometimes less than an inch, between the cage and the wall plates, and while passing the 120 ft. level Anderson turned to look at a man who was standing there with a light, and it is supposed by this movement shifted one of the short drills on which he was standing until it projected far enough from the floor of the cage to catch in the timber. The drill was tilted up, and Anderson's feet were thrown off the cage, while at the same time one of the longer drills was hurled forward against him, forcing him out of the cage, which was not provided with a guard railing. Before the cage could be stopped the victim was caught between the cage and the next wall plate, and he was badly squeezed. He was sent at the request of his relatives to the hospital at Port Arthur, where he died after a month's illness. The cage was not provided with the required safety appliances, and was hence unsuitable for raising or lowering men, but there was a notice posted at the shaft mouth forbidding riding in the cage, and instructions to the same effect were left in the Inspector's Book previous to the accident. It was however the almost universal practice for the men to disregard these orders when the manager was not in the vicinity, but since the accident the men have been more careful.

In view of the fact that the men had been forbidden to use the cage, and were only in in the habit of riding up and down during the absence of the manager, it is evident that the blame falls upon the men themselves, and that the authorities had done all in their power to prevent accidents.

AT THE VANKOUGHNET MINE.

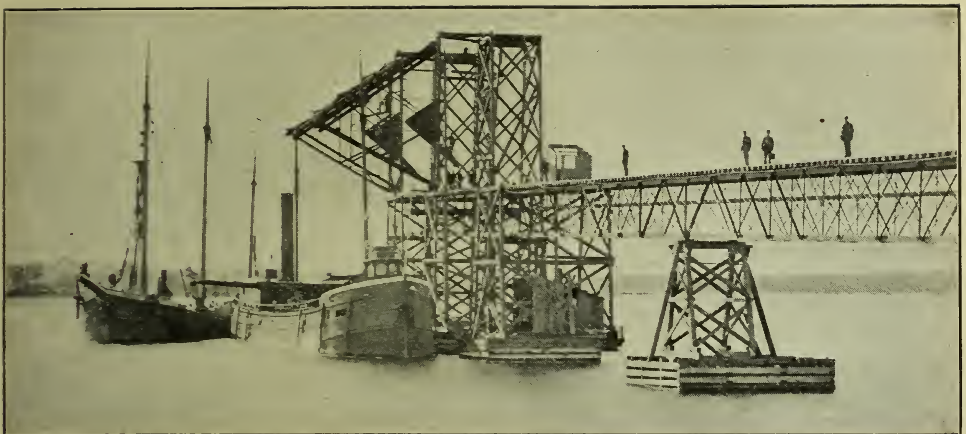
On the 8th of November an accident occurred on lot 14, con. 9 Foley, known as the Vankoughnet copper mine; the property belonged to a company known as the Niagara and Georgian Bay Mining and Development Co. Ltd., which had only been provisionally organized and was not yet incorporated. A contract for the work was let to a man named Jacobs, who had full charge of the work. On the date mentioned one of the men, Hugh Vankoughnet, was being hoisted in the bucket and had nearly reached the surface, when in some unexplained manner the bucket upset and Vankoughnet fell some 37 ft. to the bottom of the shaft. Three ribs were broken, the skull was injured, the hip fractured and there were other injuries, so that the unfortunate man lay unconscious for two days.

AT THE WILCOX MINE.

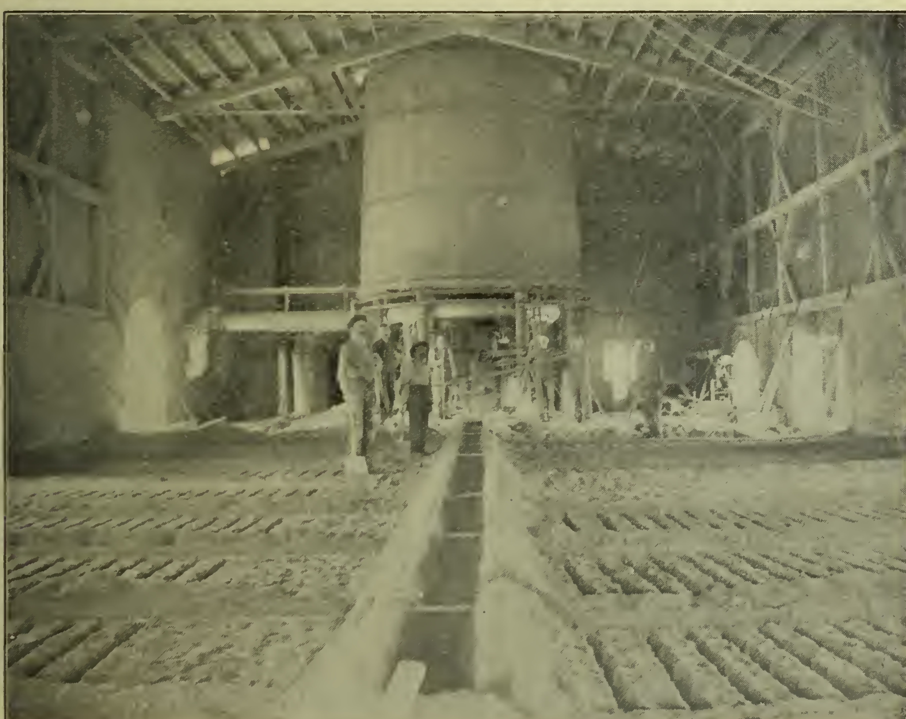
On November 16th two men were injured at the Wilcox mine, belonging to the Parry Sound Copper Mining Co., Ltd., by an accident to the hoist.

The day shift were going off and the night shift were starting when the mishap occurred. The two men, Robert Adair and M. McMichael, had just stepped on to the bucket to go below, and had been lowered about 20 ft. when the nut on the bolt which fastened the hand brake to the frame came off and the bolt dropped out. This of course rendered the brake entirely useless, and the operator threw the hoist into gear to try to break the fall. It was impossible to do much however, and the men fell 40 ft. to the bottom of the shaft. The company's physician was in attendance as soon as possible, and it was found that Adair had his right knee injured and a bruise on his head, while McMichael had a severe sprain in the right leg and was thought to have been injured internally. Both men however recovered entirely after a short time.

Inspector DeKalb, commenting on the accident, stated that it appeared to be due to the cheap construction of the hoist in having only one brake, while no machine used for the raising and lowering of men should have less than two. He remarked that it was also objectionable to raise or lower men in buckets except where a crosshead was employed as a guide, and since this was inconvenient for the men they were practically forced to use the ladderway. In all cases a manway should be provided unless the hoist has been inspected with reference to safety in raising and lowering men, the men should



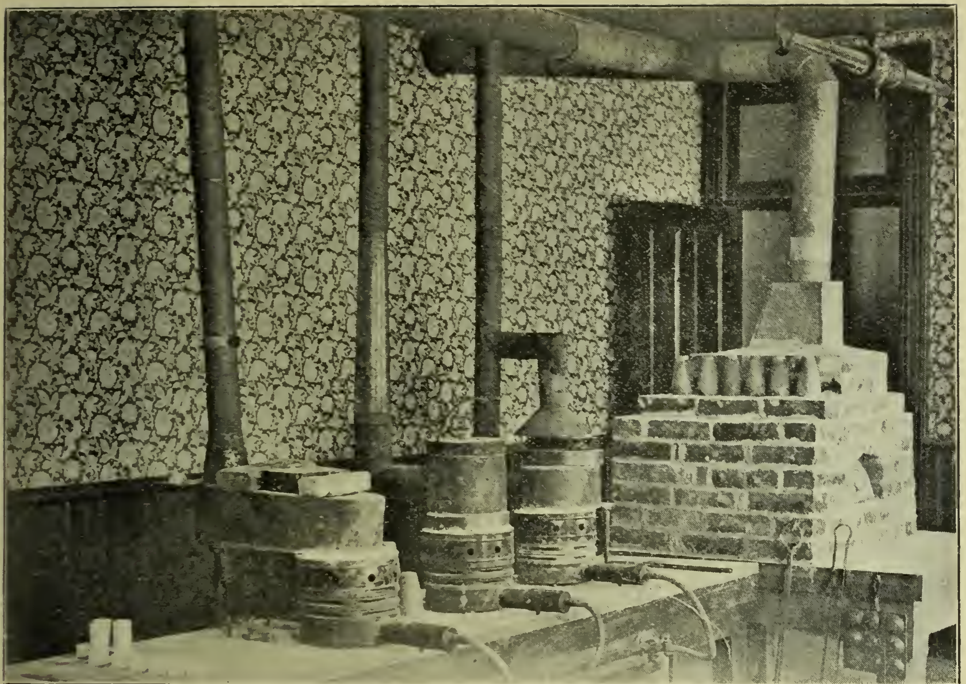
5. Unloading Pier of Blast Furnace at Deseronto, pp. 15, 102.



6. Cast House of Deseronto Blast Furnace, pp. 15, 102.

7. Laboratory of Deseronto Blast Furnace, p. 33.

8. Provincial Assay Office, Belleville, p. 33.



9. Furnaces in Provincial Assay Office, Belleville, p. 33

10. Analytical Room of Provincial Assay Office, Belleville, p. 33.

11. The Sultana Gold Mill, p. 38.

12. Burley Gold Mine in Lake of the Woods, p. 42.

be required to use the ladders. Another objection to the use of buckets for hoisting and lowering men is that a hood cannot be provided as is done on a cage to shield men from articles falling from above. These provisions with some others have been embodied in the Mines Act.

THE PROVINCIAL ASSAY OFFICE.

The Provincial Assay Office at Belleville changed its quarters during the year and now occupies two flats and six rooms on No. 24 Victoria avenue. The first flat is used for an office, for sample room and for store room. The office contains five excellent cabinets holding collections of economic minerals and rock specimens, comprising in all about three hundred which are available for reference. The sample room contains pulped samples for reference and a collection of rough samples from all of the developed properties in eastern Ontario. The store room contains chemical supplies for the practical work of the office. The second flat is divided into a balance room; an analytical room, with three fume chambers, work tables, volumetric stock solutions and laboratory apparatus; a furnace room, containing one large Hoskins muffle gasoline furnace, one set of Brown gas furnaces, work tables, etc; and a crushing room, containing rock crusher, Wetherhead pulverizer, mortars, sampling tables, etc.

The laboratory work consists of (1) assays or determinations of values of gold, silver, copper, nickel, lead, zinc and platinum; (2) analytical quantitative determinations of metallic iron, sulphur, phosphorus, titanium dioxide, silica, magnesia, etc.; (3) qualitative determinations; and (4) identification, by the determination of the names or characters of mineral specimens, with constituents so far as can be ascertained by qualitative wet and dry tests.

The laboratory equipment allows for gold and silver assays by fire method, arrastra amalgamation and cyanide leaching, and samples can be treated up to 25 lb. in weight. For copper both the electrolytic and cyanide methods are used, and for nickel the electrolytic and the Merry cyanide methods. Lead is treated by fire assay and by the molybdate method for finer determinations, and zinc by the ferro-cyanide volumetric method. Analytical determinations are made by the best known methods in actual practice, both volumetric and gravimetric.

The samples coming from the various parts of Ontario differ in character and require special attention, so that all determinations are made in duplicate when possible with a view to reducing errors to a minimum. The laboratory undertook check or control work during the latter part of the year, and samples sent in for check results are done in duplicate always, sometimes in triplicate.

Samples received for assay or analysis of less than three pounds in weight are pulped in toto to 100 mesh fineness. A larger quantity is broken to 5-mesh and sampled down by the usual methods, when a portion is taken and pulped to 100-mesh. All determinations except those requiring impalpable powdering in an agate mortar are made on samples of 100-mesh.

The assay bead balance in use for weighing gold residues and silver beads is sensitive to the th of a milligram, giving gold values to twenty cents per ton of ore. The short-beam analytical balance reads to $\frac{1}{10}$th of a milligram. These balances answer very well for ordinary work.

The following table gives a record of the work done at the Office during the year:

Assays:	For B. of M.	For the Public.	Total.
Gold	197	672	869
Silver	18	136	154
Nickel	6	50	56
Copper	10	162	172
Cobalt	..	1	1
Lead	3	3	6
Zinc	6	3	9

Analytical Determinations:	For B. of M.	For the Public.	Total.
Metallic Iron	15	48	63
Silica	14	27	41
Phosphorus	10	22	32
Titanium dioxide	11	23	34
Sulphur	17	33	50
Arsenic	..	9	9
Lime	4	15	19
Magnesia	4	3	7
Alumina	4	3	7
Ferrous Oxide	4	4	8
Ferric Oxide	4	5	9
Soda	4	3	7
Potassa	4	3	7
Moisture	8	5	13
Carbon dioxide	5	..	5
Sulphuric acid	5	..	5
Chlorine	5	..	5
Platinum	1	5	6
Manganese	1	1	2
Carbon	10	3	13
Ash	10	3	13
Volatile combustible	10	3	13
Organic matter	3	3	6
Totals	393	1,248	1,641

There were received 304 samples for identification, or qualitative examination more or less complete, of which 224 were reported on free of charge. This class of laboratory work is probably of as much value to prospectors as an actual assay or analysis, and therefore it was determined during the year to charge a nominal fee for the work. The following table gives the fees collected at the Office for each month of the year.

Months.	Assays and Analyses.	Identification.	Total.
January	$40.80	.....	$40.80
February	35.10	......	35.10
March	28.20	......	28.20
April	35.45	.....	35.45
May	60.35	......	60.35
June	117.05	......	117.05
July	101.10	......	101.10
August	130.65	.....	130.65
September	161.55	$10.00	171.55
October	152.75	5.00	157.75
November	161.90	5.50	167.40
December	120.10	12.60	132.70
Totals	$1,145.00	$33.10	$1,178.10

In addition to the foregoing are fees collected at the Bureau of Mines on samples sent through that office. No certificate of assay or determination is issued until the fees are paid.

MINES OF NORTHWESTERN ONTARIO.

By James A. Bow, Inspector.

I have the honor to submit herewith my annual report on the mines of western Ontario for the year 1899.

My duties during the year have varied somewhat from the usual course. The former part of the summer was taken up in collecting specimens from the various mines for the Paris Exhibition of 1900, and incidentally in making a brief inspection of the mines visited while doing this work. During part of July and August the time was spent in making a special examination of the Golden Star mine, and at the same time all the other mines in the Lower Seine locality were visited. Since then a general tour of inspection was made over the district, in which all the principal mines and most of the locations on which work was in progress were visited. Since so much of my time was taken up in collecting for the exhibition, and especially because this work was required to be done as soon as possible, I was not able to visit every location which was being worked, although all the important places were inspected.

Very satisfactory progress has been made over the district as a whole, some localities having been of course much more active than others. There are altogether about 120 locations or properties which have been worked during the year, but on an average not more than about 50 or 60 have been in operation at a time, and only about 20 have been in actual operation the year round. It is very difficult to give accurate figures in these matters, since many of the properties are only worked intermittently, generally for a few months at a time. In order to pay a visit to every location at which mining work was being carried on it would have been necessary to travel continually during the whole year.

There are twenty gold mines altogether that have stamp mills, a few of these being only two stamp test mills. Eighteen different mills have produced gold during the year. There is a total of 331 stamps in the district. Of these, 251 are installed and either in use or ready for use. Of the remainder, 37 are in process of installation, 23 have not been in operation for years, and probably never will be again, and one mill of ten stamps has been burned down. Of the 251 stamps installed and in use, 225 are gravity stamps, and the remaining 28 are Tremaine steam stamps. Of the gravity stamps, 241 belong to gold mills and 10 to silver. Of the Tremaine stamps, 26 belong to gold mills and two to silver. Ninety-seven gravity stamps, besides several Tremaine mills, have been or are being installed since last report.

It is impossible to give accurate statistics regarding the number of men employed in mining in the district, but approximately there are about 1100; of whom about 50 per cent. or 550 are miners. About half the total number, or 550, are employed at the producing mines when they are all in operation, and of these about 225 are miners. Of course these figures constantly vary throughout the year.

The depths of the principal mines are as follows, the date representing either the time of my last inspection or the date of my latest information: Sultana, 530 feet, March, 1900; Golden Star, 480 feet, Jan., 1900; Regina, 475 feet, November, 1899; Foley, 420 feet, May, 1898; Mikado, 300 feet, March, 1900; Olive, 251 feet, Jan., 1900; Triumph, 226 feet, 1898; Decca, 210 feet, Oct., 1899; Triggs, 210 feet, March, 1900; Sirdar, 200 feet, Dec., 1899; Virginia, 200 feet, Nov., 1899; Burley, 180 feet, July, 1899; Black Sturgeon, 170 feet, June, 1899; Manhattan, 170 feet, Oct., 1899; AL282, 141 feet, Oct., 1899; Nora, 145 feet; Bad Mine, 122 feet, Feb., 1900; Ursa Major, 117 feet, Sept., 1899; Cameron Island, 120 feet; Bullion No. 2, 112 feet, Dec., 1899; Bully Boy, 115 feet, March, 1900; Black Jack, 110 feet (?), Oct., 1899; Lucky Coon, 108 feet, Oct., 1899; Sykes mine, 108 feet, Feb, 1900; Pettigrew's mine, 108 feet, Oct., 1899; Swede Boy, 105 feet, Oct., 1899; Roy, 105 feet, Oct., 1899; Treasure, 100 feet (?); Scramble, 85 feet; Empress, 417 feet (tunnels) Sept., 1899. Silver mines: West End, 155 feet (about) and 150 feet; Rabbit Mountain, 300 feet (?).

In former years gold was almost exclusively the object of the prospectors, but recently they have turned their attention to the commoner ores of iron, copper and zinc.

Deposits of iron ore have been sought for quite actively, and prospecting work has been carried on for the purpose of testing some of the properties ; for this the new railroad is largely responsible.

Prospecting for copper has been prosecuted, but with no very encouraging results so far. The Port Arthur district has been explored for many years, but it is a very difficult country to prospect, and it will not be surprising if deposits of copper remain undiscovered for many years to come ; in all likelihood, both copper pyrites and native copper will be found in paying quantities in the region.

Zinc has attracted attention recently on the north shore of lake Superior, and the investment of capital in an enterprise to mine the ore of that metal has had its natural effect in stimulating prospectors to a more diligent search for new deposits. The results appear to be encouraging, and prospecting will probably be carried on actively during the summer.

Silver mining remains very much the same as during the previous year ; the future, of course, depends largely upon a variation in the price of silver.

There has been an unusually large number of accidents, especially of those resulting fatally, during the year ; but I do not think this undue proportion over previous years is necessarily to be accounted for wholly by any material change in conditions. The law of chance must be taken into consideration. Carelessness in dealing with explosives has been the most prolific source of trouble, and in some cases inexperience is at the foundation of the accident. But the experience of the past year should act as a preventative to a certain extent in the future, if the facts of the accidents are properly made known. I leave instructions forbidding riding in the bucket, skip or cage at all mines, for I find this practice almost universal, and it is dangerous on account of the fact that none of the hoisting plants in western Ontario are properly equipped for such work. There is no doubt that the changes about to be made in the mining regulations will have a beneficial effect.

LAKE OF THE WOODS REGION.

For the sake of convenience I will commence with the mines near Rat Portage, and proceed along the east shore of the Lake of the Woods to Whitefish bay and the country immediately to east of that.

There is quite a group of mines about seven or eight miles east of Rat Portage, and south of this working mines are sparsely scattered all down the eastern shore of the lake in Bald Indian, Big Stone, Andrew and Witch bays, and further south in Regina and Camp bays.

None of the mines of the group near Rat Portage have been extensively developed so far. In fact, none are more than prospects. During the past they have been worked intermittently, usually for only the short period of a few months at a time ; there are never more than three or four, or perhaps half a dozen, in operation at once. Some have been abandoned, others are temporarily closed down, and so forth. Among these mines there has been the usual activity during the year. It appears that the future outlook hinges to a large extent upon the sale of the Scramble mine, which has been so much talked of within the past two years. A new era of development will certainly commence among these mines if such a deal is consummated.

BULLION MINE.

There is a property consisting of location 263 P about three miles northeast of Rat Portage, known as the Bullion mine, which has been worked for a few months during the summer. It is owned by the Gold Bullion Mining Company of Ontario, Limited; head office, 808 Prudential Building, Buffalo, New York. A. E. Higgins was superintendent of the mine; only a small force was employed. The work consisted of test-pitting. I did not visit the property.

RAINY RIVER GOLD MINING COMPANY.

Mr. James Weidman, secretary of the Rainy River Gold Mining Company, Limited, with head office at Rat Portage, gave me some notes on properties of the company which had been worked during the year. The company owns a number of locations on different parts of the Lake of the Woods. Operations have been confined to two properties near Rat Portage, viz., the Wimor mine and the Electro-Gold. The Wimor consists of location 289 P, containing 79 acres, situated about six miles east of the town, with good road connection. A shaft has been sunk 85 feet, and a little test-pitting done ; a force of six was employed.

The Electro-Gold adjoins the Scramble mine, and is believed to be on an extension of the same ore body. The property consists of the south half of the southwest quarter of lot 13, Jaffray township. A 50-foot shaft has been sunk, and a variable force of from six to ten men was employed.

SCRAMBLE MINE.

The Scramble mine has been examined with a view to purchase by an English company, and it is hoped and expected that the deal will go through shortly. There is an immense ore body (low grade, of course) and only a wealthy company can afford to install a suitable plant for the profitable treatment of the same. Mr. Wm. M. Strong, manager of the Sultana, is also manager of this mine. He spent a few months making a thorough examination of the mine, and a little sinking and drifting was done in the shafts during this time. I visited it on Feb. 9, but no work was going on, and the shafts contained water. It was expected that operations would be resumed soon.

BLACK STURGEON MINE.

The Black Sturgeon mine is situated on Black Sturgeon lake, about 10 miles northeast of Rat Portage. It is connected with the town by a road which is fairly good with the exception of the last two or three miles. The property consists of lot 11, con. 6, Haycock township. The owners are F. W. Gilchrist and P. Culligan, of Alpena, Mich.

I visited the mine on June 23 for the purpose of investigating an accident, in which three men had been killed a few days previously, and while there I made a regular inspection ; the mine has been closed down since the accident. There is an account of this mine in the seventh report of the Bureau.

The present shaft is new work, which has been done since the property has been acquired by the present owners. The shaft is 6½ by 11 feet in size, and is sunk on the vein to a depth of 175 feet. It is vertical for a depth of 60 or 70 feet, then inclined slightly down to within a short distance of the bottom, when it is again vertical. At a depth of 93 feet a drift has been driven west 13 feet, and one east 43 feet. At a depth of 170 feet a drift has been driven west 34 feet, one east 8 feet, and a crosscut south 40 feet.

The hoisting plant consists of a Lidgerwood duplex hoist with 7 by 10 inch cylinders, ⅞ inch steel wire rope 562 feet long, half ton steel bucket and pole skidway on inclined part of shaft. There is 100 feet of tramway and a half ton car.

The air compressing plant consists of a four-drill Ingersoll Sargeant compressor, a receiver 8 feet long by 36 inches in diameter, and three drills. The boiler is 50 h. p., locomotive style. The drainage pump is stationed at the first level. Buildings consist of shaft house, engine and boiler house, blacksmith shop, office and boarding camps.

Just before closing the total force was 14 or 16, including 10 miners. George Thurber was foreman, and P. Culligan manager.

The mine is not in suitable condition in several respects. The shaft mouth is not fenced, although trap doors are provided. The ladderway is suitably constructed as far the first level ; below this there is only a hanging ladderway to within 20 or 30 feet of the bottom, and it is not partitioned off from the hoisting compartment. The hoist brake is in unsuitable condition. The following instructions were left in the Inspector's Book : 1, Place a suitable guard rail around the shaft mouth. 2, Construct ladderway as required by the Mines Act to within 30 feet of the bottom. Below the permanent ladderway suspend a suitable chain, or wooden ladder, so that miners can ascend and descend between

the bottom and the surface without the use of the bucket. 3, Do not allow riding in the bucket. Post up a notice to this effect in a conspicuous place in the shaft house. 4, I would recommend that the brake be tightened so that a bucket full of rock can be held by the application of the brake alone, without the aid of the friction clutch.

TREASURE MINE.

On Feb. 8, 1900, I visited the Treasure mine, which is situated about seven miles east of Rat Portage. It consists of locations 400 and 409 P, which contains 40 acres each, and is owned by A. B. Upton of Duluth. Work has been going on intermittently, during the past year or two. There is a shaft about 100 feet deep, with drifting and crosscutting at the bottom, but this was full of water at the time of my visit. A new shaft has been commenced, about 100 feet northeast of this one; it was 28 feet deep, and is still being sunk. It is timbered for a depth of 17 feet. Alongside the shaft there is an open cut on the vein 45 feet long, 17 feet deep and five feet wide. Comfortable boarding camps and other buildings are on the property. George Tennant is foreman and contractor. Four miners are employed.

BAD MINE.

On Feb. 8, 1900, I visited the Bad mine, which is situated south of the railway track, about 10 miles east of Rat Portage. The property has been bought by the Bullion Mining Company of Ontario, Limited, and development work resumed after nearly a year of idleness. There was an old shaft on the property about 70 feet deep, and a tunnel driven in at the bottom of the hill, meeting the shaft; the length of the latter is 112 feet. At the time of my visit the shaft had been sunk to a depth of 40 feet below the tunnel, making the total depth from the surface 122 feet. The vein had pinched out where the shaft and the tunnel met, but had widened out to five or six feet at the bottom. There was no ladderway or skidway; the bucket slid on the bare rock. Instructions were given to provide for these deficiencies. The sinking is being done by contract by James Gordon. A force of six miners is employed.

SULTANA MINE.

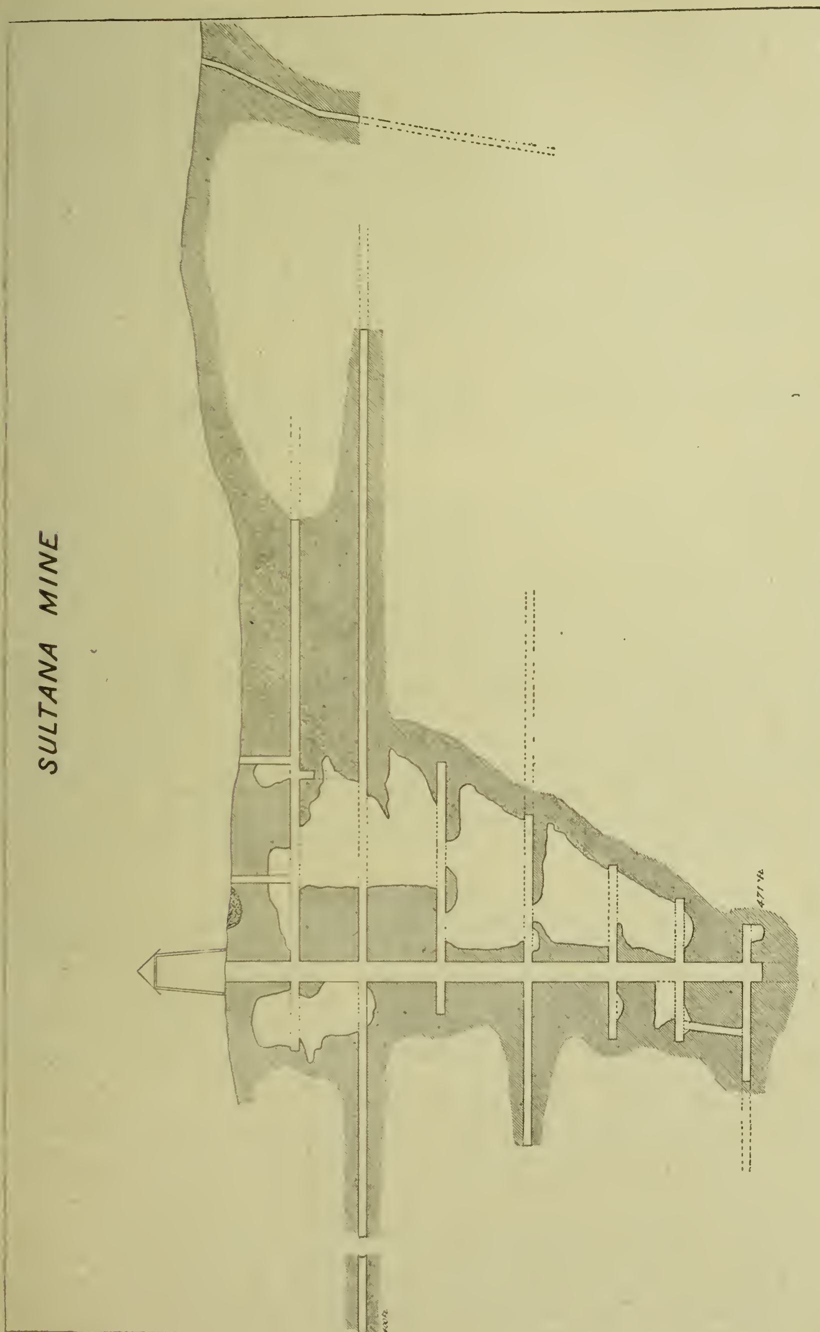
For the past two or three years the report has been periodically circulated that the Sultana mine was sold. For a considerable time extending up to the past year the property belonged to John F. Caldwell of Winnipeg, Man., and it had always been considered by the public in this vicinity a desirable thing that the mine should be in the hands of an English company, in order that the output might be made public and the district advertised in English mining circles through the medium of this property. Under the private ownership the output of the mine was never published, and it was always more or less of a mystery to all but those who were in the inner circle, or whose business it was to know. Various rumors were in circulation, and various conjectures were made. Some were to the effect that Mr. Caldwell was not anxious to sell; others that he wanted, or was offered, a very large sum, up in the millions; and still other reports were directly to the opposite effect. However, Mr. Caldwell has at length succeeded in disposing of the mine to an English company, receiving in payment fully paid up shares to the extent of the whole of the purchase price.

The name of the new company is the Sultana Mine of Canada, Limited; capital, £275,000 in 275,000 shares of one pound each; head office, London, England. The directors are the following:

Leonard Fawell, Esq., J. P., director Lake View Consols, Limited, chairman; Sir Gerald Fitz Gerald, K. C. M. G., Deputy-Chairman Anglo-American Telegraph Co, Limited; W. Rhodes, Esq., Director Mashonaland Agency, Limited; Wilberforce Bryant Esq., Chairman, Messrs Bryant and May, Limited; John F. Caldwell, Esq., Winnipeg, late owner, Advisory Director in Canada; Secretary, Hugh C. Rabbidge, 32 Poultry, E. C.

The company was formed and incorporated in July, 1899, and the objects of the company are to acquire, further develop and work the Sultana mine, and also any other mining property acquired at any time, and to carry on any other business accessory thereto. A detailed statement of the objects of the company is contained in the prospectus. The

Sultana mine was examined and reported on by Wm. M. Strong, M. E., the General Manager in Canada, and the company have been in possession since Aug. 12, 1899.



Scale: 170 feet=1 inch.

The mill was in operation up to Sept. 1, treating ore which had been broken down before the new owners took possession, and which therefore belonged to Mr. Caldwell. Since then it has only been run for a few days each month to dispose of ore resulting from

development work. The new company have started in by doing systematic exploitation without any actual mining of ore, and it will probably be some time before the mill will be in regular operation again.

Operations have been principally confined to the main shaft workings. On the occasion of my last visit of inspection, Jan. 4, 1900, the shaft was 461 feet deep, with a six foot sump below this, and arrangements had been almost completed for the continuation of sinking by subsidiary hoisting machinery, such as has been employed ever since the skip was installed. The following new work has been done underground since last report.

First Level, south : The drift has been driven an additional 58 feet, and the ore stoped out overhead to a height of 35 feet, with a width of 8 or 10 feet, and this stope abandoned. The crosscut, which extends from this level to the air shaft, has been continued to No. 2 air shaft, an old shaft which had been sunk several years ago on a vein behind the mill, and distant 250 feet from the main shaft, following the course of the drifting. Drifting has been carried beyond this shaft to a total distance of 597 feet from the main shaft, and will be continued for some distance farther to strike a body of quartz which is known to exist by surface showings.

At the place where the crosscut from the first level meets No. 1 air shaft a drift has been driven south a total distance of 264 feet from the air shaft, on the "Gagne" vein, and discontinued. Further on in the crosscut another drift, said to be 25 or 30 feet long, has been driven south from the crosscut and abandoned, and the entrance boarded over to prevent accesss.

No. 2 air shaft has been sunk below the first level a distance of 12 feet, and will be continued. The extension of this shaft below the level is considered an independent shaft, and is known as the "Galena" shaft on account of the large amount of galena that was found in this vein at this point. A drift has been driven northeast a distance of 70 or 80 feet from the crosscut at this point, and abandoned.

Second Level, north : The north drift in this level has been driven a total distance of 400 feet from the shaft, and discontinued for the present. At a distance of 375 feet from the shaft in this drift a bunch of quartz about 10 feet wide was passed through, and the drift widened at this point to ascertain the extent of the quartz body. It was expected that a large body of quartz would be struck in this drift, and further drifting may be done in the endeavour to find it; a mere seam in the rock was followed. At the end of the drift the nature of the rock could be seen on the freshly broken surface; the structure was schistose and wavy, with small stringers of quartz and calcite traversing the face in such profusion as to constitute about 25 per cent. of the whole; this material is said to assay from $1.00 to $1.50 per ton.

South: In the south drift the main workings have been described in previous reports. There is a large stope extending up to the first level and down to the third,—in fact with the exception of a little rock left for floors this stope extends to the sixth level. A neatly constructed bridge has been built across this stope at the second level and the tramway laid over same, and a drift has been driven from the south end of the stope for a total distance of 590 feet from the main shaft. This drift is being continued to connect with a shaft now being sunk on the Crown Reef vein, a distance of a little over 100 feet being still required to be driven before the connection is made. There is no vein or seam to follow, and the transit is the only guide.

North of the main stope in this level an overhand stope has recently been made 40 feet long, about 40 feet in height above the floor of the level and about 8 feet wide, and timbered over underneath. This and all other stoping was done previous to the transfer of the property.

Third Level: No work was going on in this level at the time of my inspection; but some prospecting drifts had been run from the main stope south of the shaft, and a little stoping had been done also since last report. One drift or crosscut has been run east under the lake from the east wall of the stope, a distance of 119 feet. The rock at the end of this drift is similar in appearance to that at the end of the north drift in the second level; being full of small stringers of quartz and calcite, and possessing a wavy schistose character; it is said to assay from $1.00 to $1.50 per ton.

Another drift has been driven 30 feet northeast from the main stope, and overhand toping in the drift carried up to a height of 50 feet with a length of about 9 feet and a

width of the same. At the top the stope is broken through to the main stope. A third drift has been driven 10 feet south from the main stope.

Fourth Level, north : The north drift in this level has been driven altogether 150 feet from the shaft, and discontinued. The south drift has been driven 155 feet altogether and is being continued to meet the Crown Reef shaft, similarly to the second level.

Fifth Level : No work was going on in this level at the time of inspection. The large stope south of the shaft which extends to the sixth level has been timbered over, providing a floor to the fifth. An opening has been left for ventilation and properly fenced.

Sixth Level : Work was suspended at the sixth level also. The north drift has been driven 55 feet, and the south 60 feet. A winze connects with the seventh level at a distance of 43 feet north of the shaft. The following stoping has been done in this level since last report : North of shaft, length, 40 feet ; height above roof of drift, 15 feet. South of shaft, length, 50 feet ; height, raised to fifth level.

Seventh Level : The seventh level has been established at a depth of 461 feet, and a large loading chamber provided, as at the preceding levels. The north drift is 7 by 7 feet in cross section, has been driven 97 feet and is continued. Two branch drifts have been driven east and west from the main drift, 10 feet and 5 feet respectively.

The south drift is 10 feet in width by 7 feet in height, 33 feet in length, and has been discontinued. A cistern 16 feet square and 12 feet deep has been sunk at the south end of this drift, and two pumps installed.

The skip road has been extended to the seventh level. No other change has been made in the hoisting plant.

On the Crown Reef, which is apparently a good vein, a shaft has been sunk in the open cut, following the vein to a depth of 122 feet, and is being continued. Connection is being made with the levels from the main shaft, as stated before. The shaft on the vein will serve as an air shaft when completed, and all ore will be trammed to the main shaft along the underground levels ; a small hoist worked by compressed air has been installed. A road has been constructed from the shaft to the main surface workings. As additional compressed air has been required, the old straight line compressor previously used on the property has been again installed in conjunction with the present duplex compressor, and an addition built to the engine room for it. A new machine shop has been built and provided with lathe, drill and other machinery. The company intend to build a small foundry so as to be able to make any small castings necessary, and they will also make shoes and dies. No change has been made in the mill or the chlorination plant.

The following new buildings have been erected on the property : Machine shop, manager's dwelling, mill superintendent's dwelling, new sleeping camp, and three private dwellings for employees.

The mine captain is Albert Johnson ; mine foreman, Anton Anderson ; mill superintendent, Alex Cotter. The total force is 85, and the number of miners 30.

The Sultana has the best ladderway of any mine in the district. For a short distance from the surface the shaft is smaller than the main portion, but below this the cross section is 8 by 18 feet, and the ladderway is 8 by 8 feet. It is well cased off from the hoisting compartment to the bottom of the shaft. A portion of the casing between the second level and the surface was blown off by the accidental explosion which occurred in the first level on Jan. 1, but this was to have been replaced immediately. Neatly constructed platforms or landings are provided at intervals of 15 or 20 feet all the way down. The ladders are all heavily constructed, with iron rungs, and are set at convenient angles. The ladderway is convenient and safe for travelling up and down, and should last for many years without repair.

The first and second levels north have been left in a dangerous condition as a result of the explosion mentioned above. The stulls covering the stopes have been blasted away, leaving both levels in a precarious condition. A special report of this accident was made to the Director of the Bureau of Mines. The Galena shaft is not fenced, and is hence in a dangerous condition ; the winze in the sixth level north is in the same condition. Powder has been found lying in open boxes in two or three instances underground, and other evidences of carelessness in the disposal of it have been observed. Ventilation is satisfactory. Drainage is secured by two pumps at the seventh level and one at the fourth. There is a considerable flow of water from the seams in the seventh level, owing to the loose nature of the ground there.

The following instructions were left in the Inspector's Book :

1, Repair casing between ladderway and hoisting compartment between the second level and the surface.

2, If first and second levels north are to be used again, replace stull timbers, which were blown off by the explosion ; or if these levels are not to be used fence off the drifts to prevent access.

3, Provide a guard rail at Galena shaft.

4, Fence winze north of shaft in sixth level.

In consequence of the accident of Jan. 1, the following additional instructions were left in regard to the handling of powder :

5, Keep all explosives and detonators underground in separate chests with lids, and do not allow these materials to be left outside of the chests.

6, Keep all explosives, etc., at a safe distance from the shaft, or where any work is going on, or where men are in the habit of passing.

7, Remove all loose sawdust and empty boxes from the proximity of explosives.

8, Keep powder-thaw cans thorougly clean.

9, Instruct all miners underground in the proper handling and thawing of dynamite.

BURLEY MINE.

The Burley mine has been closed down since June, 1899. R. H. Flaherty resigned his position as manager in April, and was succeeded by P. W Webster, who filled this position until the mine was closed down. The shaft was allowed to fill with water. Later on in the season it was pumped out again by J. Burley Smith and examined, and again allowed to fill. Frank Hockley, who is managing Mr. Smith's business in Rat Portage, gave me the following underground measurements of work done since last report : Depth of shaft, 180 feet ; second level at depth of 150 feet ; crosscutting east and west at this level, about 20 feet altogether.

HAY ISLAND MINE.

Operations were resumed for about three months during the summer at the Hay Island mine. I did not visit the property, but got the following information from Frank Hockley, who was superintending the work : The shaft is 103 feet deep ; first level, at depth of 100 feet. A total amount of about 215 feet of drifting and crosscutting has been done at the level. On an average, five miners were employed.

SCOTTY ISLAND MINE.

The Ottawa Gold Mining and Milling Company, Limited, have an option on JC100, a 44 acre location on Scotty island, and have been operating on the property since July, 1899. The location is owned by Frank Gardiner and George Derry of Rat Portage. The company owns JES154, a water location of 96 acres adjoining JC100. The boundary between the locations is the shore line of the island. The vein has a strike of northeast, and outcrops under water parallel and close to the shore. The formation is either chloritic or hydromicaceous schist. I visited the property on Nov. 26 and found a vertical shaft 4 by 6 feet in size, sunk to a depth of 55 feet in the hanging wall, about 30 or 40 feet from the vein. It was timbered and lagged for a depth of 18 feet. A shaft and engine house had been built, and a small duplex hoist with a vertical boiler installed. H. A. Guess, assayer at the Keewatin Reduction Works, is in charge of the work. The total force is 11, and the number of miners eight.

Mr. Guess informed me on Feb 6, 1900, that the shaft had reached a depth of 65 feet ; and at the depth of 60 feet a crosscut had been driven southeast 25 feet, passing through the vein at the end. A drift had been driven 30 feet east on the vein, and a winze had been sunk in the crosscut 15 feet on the vein.

BLACK JACK AND GOLD HILL PROPERTIES.

Early in October the Black Jack and Gold Hill properties, situated in Big Stone bay and mentioned in previous reports of the Bureau, were acquired by the Britannia

Consolidated Gold Mining Company of Ontario, Limited ; head office, Temple Buildings, Montreal ; president, Dr. Lovejoy ; secretary, Bannell Sawyer. The properties had not been in operation for nearly two years previous to this. Mr. A. B. Upton, the former owner of the Black Jack, had done some work in the shaft just previous to the sale. The manager of the mine is D. C. T. Atkinson, and the foreman Wm. James. At the time of my visit, Nov. 20, the total force was 15, including a variable force of miners of from two to eight.

Mining operations were confined to the Black Jack shaft. The following are the measurements of the old workings : Depth of shaft, about 110 feet (water in bottom). First level, depth, 60 feet ; crosscut north, 130 feet ; two drifts east in crosscut 12 feet and 15 feet long respectively ; drift east from shaft, 35 feet long and 7 by 7 feet in cross-section ; drift west 25 feet long, with same cross-section ; in east drift crosscuts have been driven east and west 6 feet each.

New work : At a depth of 30 feet, stoping east and west from shaft ; length, 10 feet ; height, 15 feet ; width, 3 to 4 feet. A rich pay streak occurs here, and stoping will be continued to the first level. Second level : Depth, 100 feet. A drift 4 by 7 feet in cross-section has been driven west 26 feet, and is being continued.

The ore body is a zone of green schist about 15 feet wide, impregnated with quartz in small stringers ; the strike is northeast. About 100 feet north of the shaft another ore body or " vein " of a similar nature about 25 feet wide occurs, with a strike nearly north and south, joining the former vein about 100 feet from the shaft. The crosscutting at the first level was done to reach this vein, and the drifting at the second level is for the purpose of reaching the junction.

The shaft had been left in poor condition by the previous operators, but a considerable amount of timbering has since been done. The walls are loose and require frequent attention. A ladderway extends to the bottom, but is not in good condition. Instructions were given to case it off from the hoisting compartment, and also to fence the shaft's mouth. The pump is situated at the first level.

The machinery is all old. It consists of an Ingersoll duplex hoist with 6 by 8 inch cylinders and 36 inch drum, ⅝ inch steel wire cable, wooden kibble sliding on a pole skidway, and 18 h.p. locomotive boiler. Three sheaves are employed, the shaft house being at the top of a hill and the hoist at the bottom. The buildings consist of shaft house, engine and boiler house, office, blacksmith shop and boarding camps, all of which had been erected by the previous owners.

On the Gold Hill there is an old ten stamp mill, which has not been in operation for several years. It is being renovated and will be used to make mill tests, etc. On Jan. 22 Mr. Atkinson informed me that no work was going on at the time, and that the old dumps on the property were being treated at the mill. The mill has been burned down since my visit.

TRIGGS MINE.

The Triggs mine, which is mentioned in last year's report, was visited on Sept. 2. Some additional locations adjoining have been secured by the company, and the property now consists of the following: McA56, 129, 130, 134, 148, 189 and 190, aggregating 280 acres.

The main shaft, which is vertical, was 150 feet deep at the time of my visit, further sinking being suspended pending the arrival of steam hoisting machinery. At a depth of 40 feet a drift has been run 30 feet west and abandoned. The first level is 108 feet from the surface. A crosscut 4 by 6½ feet in cross section has been driven north 55 feet, and is being continued. Suitable timber sets are provided at intervals of every five feet in depth in the shaft, with lagging where required. A neat and roomy manway has been constructed as far as the first level, suitably cased off from the hoisting compartment and provided with platforms. The man-holes in the platforms were unnecessarily large, and instructions were left to have them reduced about one-half. Instructions were also left to provide a guard rail across the hoisting compartment at the first level and round the shaft mouth. Water is removed by bucket ; a hand blower with pipe extending down the shaft is employed for ventilation ; blasting is done by battery ; drilling by hand. The

hoisting plant consists of a Colorado whim, with hand brake applied at shaft mouth, a 14 foot iron head frame, ½ inch steel wire cable and iron kibble. I have been informed since that the steam hoisting plant has been installed.

On McA 130, one of the recently acquired locations adjoining on the west, a 5 by 8 foot shaft had been sunk 67 feet by the previous owners, and work had not been resumed in it by the present company ; instructions were given to fence it. It is situated at a distance of 1,160 feet west of the main shaft on an extension of the same ore body, which is at this point about 125 feet wide, and consists of trap broken up, and filled with quartz stringers. There is a 14 foot test pit about 50 feet southeast of this shaft, besides other small pits at various places on the property.

There is said to be a 30 foot shaft on McA 138, sunk by the former owners, but as operations were not in progress there I did not visit the place.

Buildings consist of shaft and engine house, blacksmith shop, stables, office, boarding camps, store house, dwelling house, and also boarding camps on the newly acquired locations. The force consists of 13 men, including 6 miners. T. F. Philbrook is foreman and J. H. Triggs manager.

WENDIGO MINE.

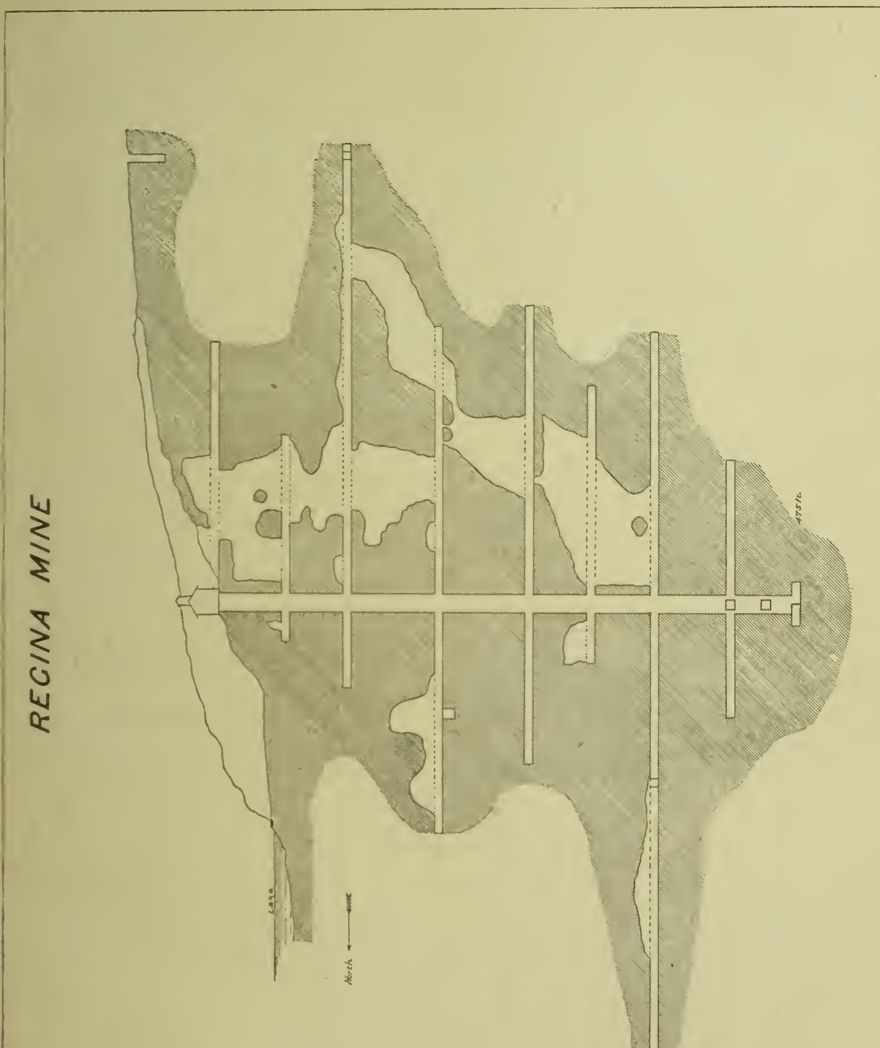
Mr. Matthew Hunter, late manager of the Sultana mine, gave me the following notes on a new property which he is opening up on Witch bay, Lake of the Woods : The property consists of three locations, MH208, 209 and 210, and is situated south of lake La Belle, north of Witch bay ; it has been christened the "Wendigo," in keeping with the name of "Witch" bay. The owners and operators are a syndicate of Canadians, among whom are Charles Gooderham, Wm. Mackenzie, Sir Richard Cartwright, Clarkson Jones and others. The head office is 37 Yonge St., Toronto.

The formation on the property consists of a variety of schists. The ore body is a quartz vein 8 feet wide, and traceable for 375 feet. One shaft has been sunk 60 feet, and a second has been started. Drifting has been commenced in the first shaft towards the second. Amalgamation tests of 100 lb. each have been made every 10 feet in depth in the shaft, yielding an average of $16 per ton. Work has been going on since Dec. 5, 1899. Mr. Hunter is manager. A total force of 25 is employed, all miners except one.

REGINA MINE.

The Regina mine has been in operation intermittently during the year under the management of J. F. Mieville. In the latter part of October work was suspended altogether and the shaft kept pumped out, awaiting examination with a view to the transfer of the property. The present mill, which has been described in last year's report, was installed by H. A. Pringle, the former manager ; and lack of funds to provide a proper mill was the reason for departing from the usual custom of employing gravity stamps and Frue vanners and substituting Tremaine steam stamps, jigs and Berdan pans. An endeavor was made to obtain a plant which would treat a considerable quantity of ore and could be installed at a minimum of expense. It is well known that Tremaine mills are much cheaper as regards first cost than gravity mills, and in the matter of capacity a Tremaine two-stamp mill is claimed to be equal to a gravity battery of five stamps, crushing from 10 to 15 tons per 24 hours. But this capacity was not obtained at the Regina. From 40 to 50 tons per 24 hours seemed to have been the best results that could be obtained from the seven mills, or 14 stamps, which had been installed there. There was always a considerable amount of trouble in keeping the batteries in adjustment and in regular operation. But how much of this was due to the incompetence of the mill men and how much to the defects of the machinery, I am not in a position to say ; however there is no doubt but Tremaine mills are much inferior to gravity stamps in a mill of this size. Tremaine mills, on account of their cheapness and portability, are more suitable for prospecting purposes. Another thing, a large quantity of fuel was required to supply steam for the 14 cylinders. The Berdan pans were stopped, being considered useless. On the whole the mill gave poor satisfaction, and it will in all probability be replaced by a gravity mill when a new company takes hold of the property.

The cyanide plant was kept in operation until all the concentrates were treated. A treatment of about four weeks duration at least is given, but on account of the surplus capacity the length of treatment was usually extended to five or six weeks. A new furnace has been built for roasting the cyanide slimes and retorting.



The shaft is now 475 feet deep. No drifting has been done above the sixth level since last annual report. The north drift in this level has been driven 380½ feet altogether. At the seventh level, the north drift is 85 feet in length, and the south 120 feet. At a depth of 452 feet a crosscut has been driven east 18 feet, cutting the vein, which at the seventh level dips into the hanging wall. At the bottom of the shaft the eighth level has been established with cross-cutting north 18 feet, passing through the vein and drift-

ing north and south on the latter, 35 feet altogether. These are the measurements of Oct. 14, the date o my last inspection. In the third level north, at a distance af 90 feet from the shaft, a w nze has been sunk 12 feet, revealing a good width of vein.

The following are the dimensions of the stopes in the levels where this work has been going on since last report. Fourth level, south : average length, about 50 feet; height, raised to third level. Fifth level, south : length, 120 feet; height, 36 feet above roof of drift, and broken through to fourth level at a distance of 95 feet from the shaft. North : length, 35 feet; height, 18 feet above roof of drift. Sixth level, south : length (average), 85 feet; height raised to fifth, leaving pillar 12 feet in diameter in lower part of stope for support. North : length, 135 feet; average height, about 5 feet above roof of drift. Seventh level : raise commenced 20 feet south of shaft.

The vein in the lowest workings is wider than usual, and possesses good walls. At the seventh level it is 7 feet wide at the shaft, although narrower in the drifts. At the end of the crosscut, at a depth of 452 feet, the width is 6 feet; and at the 8th level, it is 7 feet 8 inches, with good walls and selvage on hanging. At the ends of the drifts in the eighth the vein is narrower, ranging from 4 to 6 feet. Mr. Mieville tells me that the ore averages about seven dollars per ton. The mine looks very encouraging, therefore, at the lower levels, the vein being much stronger than on surface; and it is hoped that the disposal of the property will be effected in the near future in order that it may be given a fair test. No change has been made in the hoisting or drilling plants, or in the mill. Last winter a tunnel was driven 30 feet south on a vein about 900 feet east of the main vein, and discontinued.

At the time of my inspection of April 12 there was a total force of 50 men, including 16 or 18 miners. Drifting and stoping were in progress, and the mill was running 10 hours out of the 24. On June 20, the time of my second visit, the total force was 20 with 4 miners. Sinking in the main shaft was the only work being done. The mill had been stopped on May 7. The mine was visited on two more occasions, Oct. 14 and Nov. 25.

The mine was in satisfactory condition, with the following exceptions: The ladder way below the seventh level is not cased off from the hoisting compartment, or otherwise constructed according to the Mines Act. Instructions were left to have this attended to, and also to fence the winze in the third level south.

A fatal accident occurred in the shaft on June 1, and a special report on it was sent in to the Bureau.

STURGEON LAKE REGION.

The Sturgeon Lake or Deer Lake country east of the Regina mine, or of Whitefish bay, is attracting a considerable amount of attention at present. There are now four properties upon which substantial development work is in progress, and a 15-stamp mill is being erected on one, the Gold Panner. This will, according to present indications, prove to be a region of large low-grade as well as small high grade propositions. There will doubtless be a number of new properties opened up during the coming season. The Anglo-Canadian Gold Estates, Limited, of London, Eng., which is one of the companies operating here, is a strong corporation, and will not hesitate to supply all necessary means to prove the value of their properties. The Virginia mine is owned by a substantial company, and a stamp mill will probably be erected soon.

VIRGINIA OR LIZZIE MINE.

This property, which has been named the "Lizzie," but is better known as the "Virginia" mine, was visited by me on Nov. 21. With the exception of a short period of suspension of work, active mining operations had been carried on since my previous visit of about a year before. Work was principally confined to the main shaft, but the following test-pits have been sunk on the vein also: (a) 600 feet south of main shaft; pit, 12 feet deep. (b) 400 feet south of shaft; pit, 9 feet deep. (c) 150 feet north of shaft; pit, 9 feet deep. Good values are said to have been obtained from all three.

The main shaft has been sunk to a depth of 198 feet, and is being continued. The cross section is 6 by 8 feet, and the dip 60° east. At a depth of 100 feet a drift has been driven north 12 feet. From the end of the drift a $3\frac{1}{2}$ by $6\frac{1}{2}$ foot crosscut has been driven northwest 102 feet, and one southeast 38 feet, making a total distance, including the width of the drift, of 144 feet. As stated in last year's report, the formation here consists of a band of fine-grained schist, apparently felsitic or sericitic, in which the vein is bedded. The crosscut was made to test the schist, 100 feet of which was passed through. The northwest end of the crosscut is in the granite, and the southeast wall of the schist is also believed to have been reached. Small stringers of quartz and decomposed belts occur in the schist at intervals; the whole body is claimed to be ore. It resembles the Olive and other properties on that belt of schist in the Lower Seine to a certain extent. The formation extends for miles, and if it is found that the whole width of the schist, or even a considerable portion, carries sufficient value to pay for treatment, the amount of ore will be practically unlimited. The vein proper in the shaft consists of stringers of quartz mixed with the schist. The second level will be established at a depth of 200 feet, and another crosscut will be made there similar to the one at the first level. The hoisting plant consists of the following: A Rand duplex hoist with 6 by 8 inch cylinders, $\frac{3}{4}$ inch steel wire cable, 20 h.p. locomotive boiler, two pole, iron-shod skidway, steel bucket, 30-inch sheave, and neat and substantial shaft house. The shaft has been timbered for a depth of 20 feet. A suitable ladderway has been constructed to the first level, but is not divided off from the hoisting compartment. Below the first level the ladderway is temporary and extends to within 20 feet of the bottom. Instructions were given to construct the ladderway suitably, and also to fence the shaft mouth. Ventilation is secured by means of a 10 by 12 inch wooden boxing, which extends down the shaft and conducts the exhaust steam from the pump at the first level, and also receives an up-current for the removal of smoke, etc., by a jet of live steam at the bottom. A Cameron pump, with $1\frac{1}{4}$-inch suction, is stationed at the drift at the first level. A 3 foot cistern has been sunk in the drift, and a dam 2 feet high constructed at the north end of the drift, so that the whole crosscut serves as a reservoir. Blasting in the shaft is done by battery.

The following new buildings have been erected since last year's report: Shaft house, engine and boiler house, dining camp, barn, ice house and manager's dwelling. The latter is a large building and is neatly and artistically constructed; in fact it is the finest log house in the district.

S. H. Brockunier, the secretary-treasurer of the company, is general manager of the mine, and James Rayburn is agent. The total force is 12, including 8 miners.

The company have secured the small steamer "Jenny Linn," with 40-foot keel, for running on Sturgeon lake, over which a distance of 14 miles is traversed from the mine to Dog Paw rapids. The small naphtha launch runs on Whitefish lake, a distance of 4 miles, completing the connection to the portage into Lake of the Woods. Facilities of transport are thus greatly increased by this service. In the winter time a regular stage will run from Rat Portage to this and the other mines in this part of the district two or three times a week, carrying passengers and the mail.

NINA MINE.

About four or five miles north of the Virginia there is a property familiarly known as the "Scovil-Moore" property, of which considerable has been heard. It is now being worked under bond by the Great Granite Gold Mining and Development Company of Ontario, Limited, which is operating on Shoal lake, near the Mikado. The property consists of JES 93 and 110. S. H. Reynolds is manager of the mine, and it was from him that I got this information. A shaft has been sunk 60 feet and a tunnel is driven 24 feet. The vein is said to be very fine in appearance, and to be traceable for a long distance.

ANGLO-CANADIAN GOLD ESTATES.

In view of the failure of the Ontario Gold Concessions, Limited, of London, England, a company of first class English capitalists to discover anything of value on 100 square miles of territory, which was supposed to be in the gold-bearing formation of western Ontario, it was anticipated that capitalists from that country would in the future

be less inclined to make ventures in this district, and the public here deplored the want of success of the company, fearing that a severe set back to the district would be the consequence. But instead of such being the case, the persistency of English capital has been demonstrated in the present move, in which another effort is being made in the direction of discovering gold by the prospecting of large, hitherto unexplored areas. The Ontario Gold Concessions, Limited, under a certain agreement secured by special authority from the Government the sole right of prospecting, and buying any portion of two large areas, aggregating 100 square miles, in parts of the district where no location had been applied for or where no timber limits existed, and selected by reference to the Dominion geological map without any practical knowledge of the country at the places chosen. Now a considerable portion of our district is surveyed into and leased as timber limits, many of which are likely to be retained by lease for years to come. No power is given the lessees over the mineral rights of the limits, but the Department prohibits the entering of persons upon them for prospecting purposes, and will not recognize applications for mining locations upon them. And further, the best timber often or usually grows on the best gold-bearing formation. The reason for this is obvious: The hard and rounded Laurentian granite will not hold the soil, and hence afford foundation for the growth of timber, as well as the softer schistose Huronian formations. For this reason much of the country valuable from a mining standpoint is tied up. Mr. Alan Sullivan, who was manager of one of the blocks of the Ontario Gold Concessions, Limited, recognized and had in view the above facts, and by considerable perseverance and expenditure of time succeeded in interesting prominent English mining men (not the same who were in the previous venture) in the scheme of prospecting these limits, or some of them, by securing permission from the lessees, this not being contrary to the law. Apparently with the consent of the lessees surveyors may enter and survey, and the Government will patent or lease locations on timber berths. The name of Mr. Sullivan's company is the Anglo-Canadian Gold Estates, Limited; capital, $305,000, or £61,000; offices, 9 and 10 Pancras Lane, Queen Victoria st., E. C. London, England. The following are the directors: J. Douglas Fletcher, Rosebaugh, Rosshire, N. B.; Thomas Greenwood, (Director Union Financial Syndicate, Limited); S. W. Paddon (Director the London & Westralian Mines & Finance Agency, Limited); W. Marshall Philip, M. E, Assoc. Mem. Inst. C. E., The Anchorage, Enfield; N. G. Maitland Smith, Moorgate Court, Moorgate Place, E. C.

The company was formed purely for prospecting and development purposes. The sum of $200,000 has been subscribed for working capital. This is to be employed solely for bringing properties to a certain stage of development without installing any regular mining machinery. When it is established that a proposition has developed into a mine, a subsidiary company will be formed to take over the land, and additional capital will be subscribed.

Alan Sullivan, M. E., is manager in Canada. He went over to England in the winter of 1898–99 and remained there until the formation of the company was completed, and commenced work immediately upon his return. A suitable gang of prospectors was selected and operations were commenced in August, 1899, on timber berth No. 5 on Denmark lake, east of the Lake of the Woods, there being a number of timber limits in that section of the district, and some good finds have been made there. I visited the place where work is in progress on Nov. 22. It is reached by way of the route to the Virginia mine, until within about two or three miles of that place, where a turn to the right or east is made. The following route is then passed over: Two miles up a creek to Ross lake, which is entered by a short portage of 50 yards; 1½ miles across Ross lake, a quarter mile portage over a good road into Denmark lake, and a 10-mile voyage on the latter. The property is situated at the foot of the long bay extending southwest. A small steam launch has been put on this lake by the company. A regular stage will run in the winter time.

Two locations, FM131 and 132 containing 80 acres, have been surveyed. The formation is a hard, dark-colored, fine-grained porphyry mixed with greenstone. On FM131 there are two distinct quartz veins. One has a strike of north 30° east, and is traceable and stripped for about 150 feet, having a width of from a few inches to two feet. The other vein has a strike of nearly east and west. It is traceable by stripping for about the same distance as the other, and has a width of from a few inches to three feet.

13. Mill, Shaft House, Cyanide Works and Camp of Mikado Gold Mine, p. 52.

14. Mill and Shaft of Mikado Gold Mine, p. 5?

15. Camp, Office and Manager's Dwelling of Mikado Gold Mine, p. 52.

16. Shaft House and Ore Dump of Sirdar Gold Mine, p. 56.

A 5 by 8 foot shaft, with a dip of 70° northwest, has been sunk on the junction of the two veins to a depth of 60 feet, and is being continued. The east and west vein is three feet wide at the surface, but the hanging wall of the shaft is apparently the line of faulting of the vein, as it is not exposed further down, nor does it occur on the other side of the shaft even on the surface The first mentioned, or No. 1 vein, is only 8 or 9 inches wide at the bottom, and the values are said to be low. But Mr. Sullivan told me subsequently that further sinking and crosscutting had exposed a fairly good-sized body of quartz assaying from two to three ounces. Hoisting is done by windlass and bucket, a large stone being employed as counterpoise. A steam hoisting plant is being brought in, and machine drills operated by steam will also be installed. A ladderway extends to within 15 feet of the bottom of the shaft. A test pit seven feet deep has been sunk on the east and west vein at a distance of about 150 feet from the shaft.

On the other location, at a distance of 800 feet southwest of No. 1 shaft, a shaft has been sunk to a depth of 30 feet on what is believed to be the same vein, which runs northeast on the preceding location But here the vein is much broken up, consisting of stringers of quartz mixed with the porphyry. Some specimens containing visible gold were shown me, and I was told that much visible gold was found along the surface of the vein. On the line between the locations a tunnel has been driven west 60 feet, on a body of quartz mixed with country rock about 15 feet wide at the foot of a bluff about 100 feet high The quartz pinched out in the tunnel, and a crosscut 7½ feet long driven west from the end of the tunnel did not reveal any evidence of the continuation of the vein.

The total force is 25, including 13 miners. Alan Sullivan is manager, and H. Patterson is foreman of the work.

A number of buildings, including boarding camps, private residence, offices, etc., have been erected.

GOLD PANNER MINE.

About four miles south of the Virginia mine on Sturgeon lake there is an island of 22 acres, which has been surveyed into mining location MH230 and is the property of the Gold Panner mine. It is owned by The Gold Panner Mining Company of Ontario, Limited ; capital, $999,999 ; par value of shares, $1 ; head office, Rat Portage, Ont. ; president, M. Kyle ; secretary-treasurer, John Chaloner ; managing director, Richard Hall. The company own other locations in the vicinity, but this was the only one visited, and the only one in operation at the time of my visit, although work had been done on one or more of their other properties during the year.

The formation consists of a belt of fine-grained schist, similar to that of the Virginia and parallel to it. A shaft 8 by 12 feet in cross-section and 15 feet in depth was being sunk at the time of my visit, Nov. 23. The vein is 8 feet wide, extending across the whole width of the shaft. It consists of a zone of the schist, mixed with quartz stringers ; about one half being quartz. The dip is almost nil. The walls are well defined, but on account of the schistose nature of the formation other walls may be obtained, and perhaps more quartz, by cross-cutting. Oxidized streaks extend through the vein, and the schist is much altered in places. The whole vein is well mineralized ; it is said that much visible gold is found in it. I was shown some splendid specimens that came from the mine in the office of the company at Rat Portage.

Between two and three hundred feet northeast of the shaft a test pit has been sunk 8 feet in the schist, where for a width of 8 feet the schist is mixed with quartz, but to a less extent than in the main shaft. This pit is not on the same line of strike as the shaft, being 50 feet or more to one side. It is possible that the whole body of schist, which is probably over 100 feet in width, will prove to be ore.

Six miners were employed at the time of my visit. Richard Hall, the managing director of the company, is manager of the mine, and Fred. Goulet mine captain. Work has been going on since the latter part of October, 1899. In March, 1900, Mr. Chaloner, the secretary, informed me that a 15 stamp mill was on the property in course of erection.

CAMP BAY MINES.

Activity has increased in the Camp Bay locality during the year. Some of the old mines have renewed operations, new prospects have been opened up, a stamp mill has been erected, and although work had been suspended at one mine the future prospects for this locality are encouraging.

COMBINED GOLD MINES CO.

The property of the Combined Gold Mines Company of Ontario, Limited, had also been closed down for some time, and operations were resumed this past summer. I visited the place on Oct. 17 and Nov. 25. There are several veins here upon which shafts have been sunk, but the principal ore body is a flat-lying quartz vein, which probably will average between two and three feet in thickness, underlying a capping of greenstone of about the same thickness, although the quartz is exposed at a number of points. Test pits and trenches have been made, revealing the thickness of the quartz body at various points. It is impossible without further investigation to say what the extent of the ore body is ; it may be several acres or more ; from one-half to three-quarters of an acre has been cleared for mining purposes. About 1,300 tons have been blasted out along a face of about 200 feet in length, where the deposit has been attacked for mining purposes. Test pits have been made at other places, showing the vein to gradually dip into the trap on the west. The company believed they had a sufficient quantity of ore in sight to warrant the erection of the 10 stamp mill now on the property and just completed. It is expected that the ore will average between five and ten dollars per ton.

The mill is a Fraser and Chalmers, and has been erected under the superintendence of D. V. McKillican, who represents that firm. The machinery consists of the following: Two batteries of five stamps each, a Blake crusher with 7 by 10 inch opening, three-compartment Brown's hydraulic sizer, three Frue vanners with six foot belts, two smooth and one corrugated, a 40 h.p. Corliss engine and a return tubular boiler 14 feet long and 60 inches in diameter. The building, which is neatly constructed, is of the following dimensions: Battery room 36 feet 8 inches by 42 feet, vanner room 36 feet 8 inches by 22 feet, engine and boiler room 22 by 31 feet. It is situated on Camp bay, on a convenient and well chosen site.

As the mine is about two miles back from the lake a railroad, called the "Camp Bay and Crow Lake Railroad" on account of its proximity to these two bodies of water at either end of this length, has been constructed to convey the ore to the mill. There is practically no up-grade in going towards the mill, and there are no steep grades in going the other direction until close to the mine, which is situated on top of a hill ; two switch-backs with steep grading are necessitated. The track is of 4 feet 7 inches gauge, the construction of which is interesting. Any person acquainted with the country in this part of the Province will realize the difficulties and expense involved in the construction of railroads therein. The country is principally a succession of rocky elevations separated by muskegs or swamps and lakes, with only occasional areas covered with firm soil. Thus there is involved continuous rock-cutting, grading, bridges, trestle work, curves, etc., and the muskeg always affords very poor foundation even with considerable filling or grading. Now the body of ore on this property would not warrant the construction of an expensive railroad for such a distance, so a cheap method of construction had to be employed. The road was made to follow the level ground, and hence the muskegs as far as possible, so as to avoid rock cutting. Trestle work and cribbing have taken the place of filling. At the mill end, for a distance of about 200 yards, the track is supported on a series of trusses set 16 feet apart. For the rest of the distance, where the elevation is sufficient to require it, a cribwork about 6 feet in width and 6 to 12 feet in length, consisting of logs from 6 to 8 inches in diameter, is built up at intervals of 16½ feet between centres. The elevation at the highest point is 11 feet. A heavy cross-piece is provided on top, and on the ties rest heavy stringers 16½ feet in length, notched into the cross-pieces. The rails weigh 16 pounds to the foot, and are spiked directly to the stringers, no cross-ties being employed. The whole affair, where the track is elevated, is shaky and insecure. Where the road passes through the muskeg the timbers are laid on the bare

ground. This, as would be expected, is a very soft and yielding foundation, and a continual sinking must always result (except when the ground is frozen hard), as has proven to be the case at a number of points examined. The effect of the frost must also be disastrous. The track yields under the train ; the cribwork and the soft muskeg forming a springy combination. Experiment proved that the stringers were not sufficiently stiff, and centre supports had to be provided all along. The rails are too light for the engine, and the spiking is not sufficiently strong, as spreading of the rails was observed in several places. Cross-ties should have been employed. The train consists of a nine-ton locomotive, and two cars which are supposed to carry three tons each. The road was almost completed at the time of my last visit, and was being used for hauling cordwood from various points along it to the mill.

A dock has been built close to the mill, where there is a good depth of water for steamboats.

As regular mining and milling had not commenced, the force was variable. At the time of my visit of Oct. 17 seven miners were employed, and this will probably be the number when regular work commences. W. H. Crocker is manager of the mine, A. Patterson is superintendent, and W. H. Rudd assayer and amalgamator.

BOULDER MINE.

I visited the Boulder mine on Oct. 17 and found it closed down, with nobody there but a caretaker. A neat and roomy shaft and hoist house was erected at the main shaft. The hoist and the compressor were installed, and the surface arrangements were neat and convenient. The shaft being full of water, I could not go underground.

GOLD SUN MINE.

Other properties have been and are in operation in this vicinity, but they were not visited. I got some information from Mr. A. A. Atwater, manager of a property consisting of locations JC81 and 97, and FM145, situated northwest of Crow lake, and owned by the Gold Sun Mining Company, Limited ; head office, Windsor, Ont. Six miners were employed all summer. Two tunnels, 45 and 70 feet long respectively and 600 feet apart, had been driven to cut the same vein, besides stripping and blasting along the surface.

BULLY BOY MINE.

Work on the Bully Boy mine was resumed on Nov. 12, 1899, after having been suspended for over a year. It is under option by Geo. J. Ross of Rat Portage and A. B. Upton of Duluth. Mr. Ross is manager of the mine ; J. M. Jones, formerly of the Regina, is mine captain. At the time of my visit, Nov. 25, the total force was nine, including six miners. No work was going on in the main shaft, as it was full of water and they were awaiting the arrival of pumping machinery. In the meantime a pit was being sunk several hundred yards north, on what is considered the same dike or vein. The pit was 12 feet deep at the time of my visit.

Mr. Ross, the manager, informed me on March 13 that the main shaft had been pumped out and sinking resumed. A depth of 115 feet had been reached. A steam hoist is installed.

TROJAN MINE.

I visited the Trojan mine on Nov. 24, and found operations in progress in No. 1 shaft on the hill side. This shaft was 70 feet deep, when work was suspended nearly two years previous, and at the time of my inspection was 91 feet ; sinking is being continued. A new shaft house and blacksmith shop and a hoist house have been erected ; and a small, Jenckes duplex hoist with 25 h.p. locomotive boiler installed. The shaft is suitably timbered at the surface, but is not provided with guard rail at the mouth. The ladderway is in poor condition, no division or platforms being provided ; the skidway is also insecure. The attention of the captain was called to these defects, and instructions were given to remedy them. A shaft house is being erected at No. 3 shaft on top of the hill, with a view to commence work in a few days. The total force of miners is 10 ; mine captain, James Vear ; manager of mine, Geo. J. Ross.

I was informed by Mr. Ross while in Rat Portage that the mine was being operated under option by a syndicate consisting of the following: James F. Lewis, Chicago, president of the Canadian Rand Drill Co.; S. W. Jenckes, president of the Jenckes Machine Co.; J. M. Jenckes, sec.-treas. of the Jenckes Machine Co.; E. W. Gilman, general agent of the company, and Geo. J. Ross of Rat Portage. Mr. Ross also informed me on March 13 that No. 3 shaft had been reopened, a depth of 100 feet reached, and 40 feet of drifting done in it.

SHOAL LAKE REGION.

More activity has been displayed in the Shoal Lake or Bag Bay region than during any previous year. During the winter of 1898-99 diamond drilling was in progress on several properties, followed by development work in the spring. A number of new locations, including water locations, have been taken up, and now all of Bag and Clytie bays are surveyed. Altogether about a dozen properties in the vicinity of the Mikado have been under development for the greater part of the summer and following winter, and a new five-stamp mill has been erected on one.

MIKADO MINE.

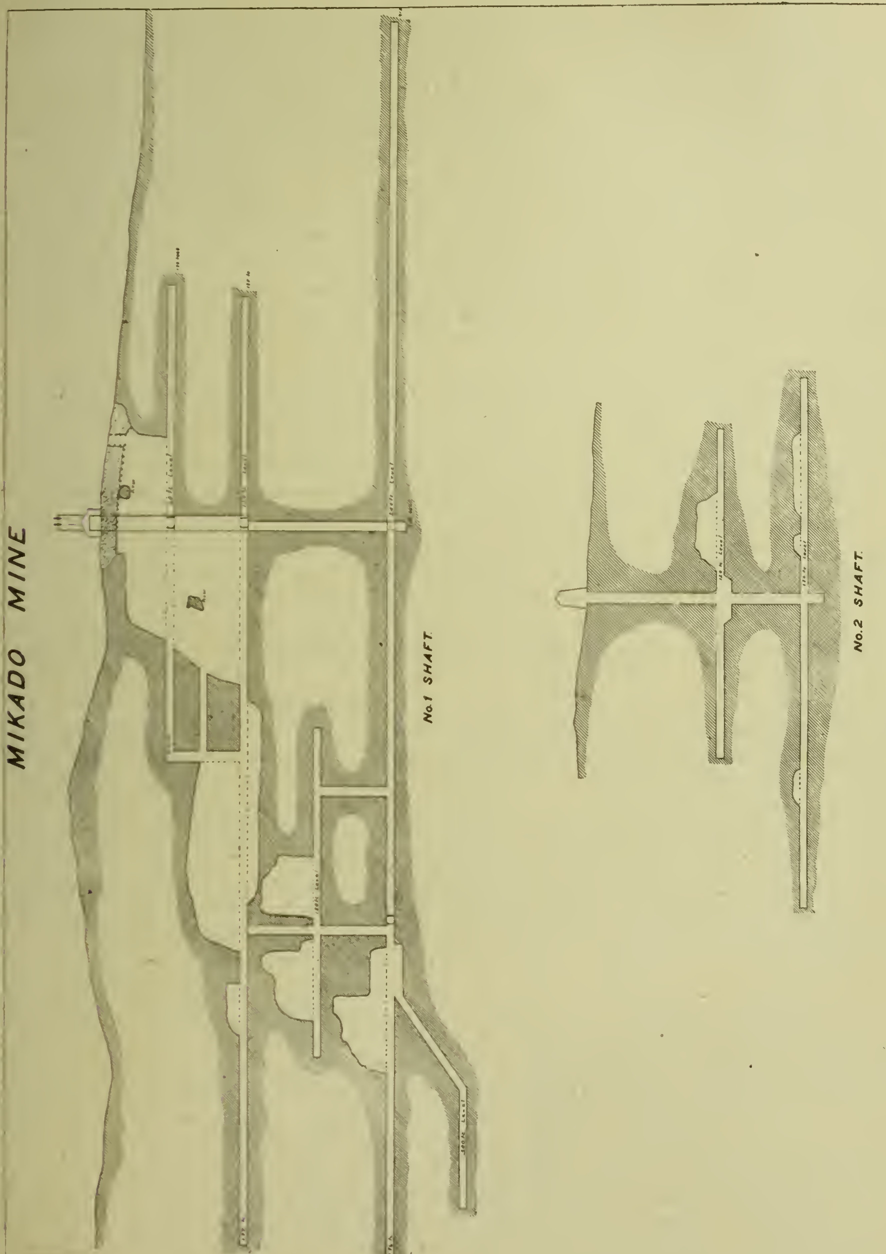
A general change was made in the management of the Mikado mine on March 10, 1899. Theodore Breidenbach, who had been manager since the commencement of operations, left the employ of the company on that date, and N. C. McMillan and F. C. Pengilly were appointed joint managers; Mr. McMillan being business manager and Mr. Pengilly superintendent of the mine and works. T. R. Deacon of Rat Portage was appointed Canadian director of the company, and to a certain extent has general superintendence over the affairs of the mine. Although the management of the mine is thus distributed among different heads, with no one person in absolute authority, matters progress quite smoothly and satisfactorily. Joseph Hicks is day captain of the mine and James McKenzie night captain. David John is battery and cyanide manager and assayer. There is a total force of 70, including 25 miners.

No. 2 shaft has been closed down since March 10, and is full of water. The hoist has been removed and the tramway to the mill pulled up. Operations may be resumed in this shaft in the spring of 1900, but not before. From the underground plan of this shaft I find that no further sinking has been done in the shaft, or no work in the first level. But additional drifting has been done in the second level; the north drift is now 178 feet in length, and the south drift 250 feet.

Operations have been confined exclusively to the main shaft and vein since the closing of No 2. Stripping and test-pitting have been done at various points for a distance of about 1000 feet south of the shaft on the main vein. The first test pit is about 700 feet from the shaft, and 10 feet deep; the second about 100 feet farther south, and 5 feet deep. About 60 or 70 feet farther a costean has been made through the soil to bed rock, depth 8 feet, length 20 feet. About 150 feet farther the vein has been stripped for a few yards and shows branching; a test pit has been sunk 12 or 15 feet at this point. The continuation of the vein is thus proven for a considerable distance south of the shaft, and although surface showings are not remarkable they are encouraging, and a test drift will likely be run from one of the levels in the main shaft to prove the vein under the test pits.

The main shaft is 250 feet deep, no sinking having been done since last report, and with the exception of drifting at the 240 foot level no work has been done north of the shaft during the year. The north drift at this level has been driven 421 feet altogether and abandoned, the entrance being boarded over. It had been the intention to continue this drift to strike the contact with the granite at some distance to the north, where there was a probability of striking a good body of ore, but as this would involve nearly 1,000 feet more of drifting the attempt was given up. The workable portion of the Mikado vein occurs in a chute which has a dip of about 30° south, as described in the previous report; and as the chute lies nearly all to the south of the shaft the present operations are now confined to that direction.

No further drifting has been done in the first level since last report. The second level has been driven south 587 feet altogether, and discontinued. At a distance of 324 feet south of the shaft in this level a winze has been sunk through to the fourth, or 240 foot level. At a depth of 60 feet in this winze, or 180 feet from the surface, drifting has



Scale : 160 feet=1 inch.

been carried south 100 feet and north 162 feet, constituting the third level, which will eventually be connected with the main shaft. The fourth level has been driven south 553 feet. The first and second levels are connected by a winze at a distance of 180 feet from the shaft. At a distance of 200 feet from the main shaft in the fourth level a raise

has been made to connect with the third level. Some very cheap work in raising and sinking was done here; the winze between the 120 and 240 foot levels was sunk by contract at $13 per foot, and the up-raise just mentioned was done for $9 per foot. At a distance of 319 feet south of the shaft, in the 240 foot level, a crosscut has been driven west 62 feet and abandoned.

It had been believed at one time that the best part of the vein was at the surface and had been worked out, but the evidence of the fourth level does not substantiate this, and as far as appearances go the good ore might extend to any depth. The ore chute is of variable width and constitution. There are two walls which range from 2 or 3 to 10 or 12 feet apart. These are more or less definite; sometimes both are well defined, and at other places only one. The material between the walls consists usually of quartz or ore and barren rock, the latter occupying the centre and the quartz occurring as stringers on the walls, and sometimes in the centre. A considerable portion of the chute consists entirely of quartz between the walls. On account of the looseness of the walls all the rock between has to be broken out, no matter how far apart and how much is barren, and nearly all of this rock is sent to the surface as it would not be practicable to do sorting to any extent down below. And although a very satisfactory output of bullion is obtained monthly the manager, Mr. Pengilly, believes that it can be increased about 20 per cent. by the aid of a sorting plant which will remove most of the barren or very low grade rock. But this will be dealt with later.

The following stoping has been done since last report: Second level, first, or "No. 6" stope, length, 116 feet; height raised to first level; second, or "No. 5" stope, length, 144 feet, height above roof of drift, 40 feet; third stope, length 40 feet, height above roof of drift, 10 feet. At a height of 30 feet above the level, in the winze that connects with the level above, a drift has been driven connecting the first two stopes, in preparation for removing the block of ore between by underhand stoping. This block of ore is about 50 feet in length. An underhand stope has also been made in this level with the following dimensions: Length 125 feet, depth 12 feet, width about 3 feet. This has been filled with broken rock and a tramway laid over it. Third level: North drift, length of stope 56 feet, height above drift 34 feet. South drift, length of stope 70 feet height 36 feet. Fourth level: Length of stope 108 feet, average height 24 feet.

At the bottom level, where all the tramming is now being done, a distance of nearly 400 feet must be traversed to reach the shaft, as this much drifting through the barren part of the vein was necessary to reach the ore chute at this level on account of the chute dipping so flatly, and away from the shaft. There being only one tramway in the drift, it is with considerable difficulty that sufficient ore can be got out to keep the mill supplied, as all the ore in the upper level is sent to the fourth to be trammed to the shaft. Another thing, with the present vertical shaft each succeeding level requires a much greater amount of dead work to be done before reaching the ore, and this has become a serious question. So a new principle is now to be put into practice in the working of the mine. An inclined shaft, with a dip of 35° south, will be provided that will follow the main ore chute. The mouth of the shaft will be at the north end of the open cut west of the mill, and the shaft will follow the stoped out portion of the vein as far as that goes. Thus there will be no dead work with the exception of the shaft itself, provided the dip of the ore chute remains regular, and even if it does vary a little the amount of dead work will be small compared to the present method. The expense in constructing the incline from the surface to the present lowest workings will not be great, as so much of the excavation is already done. This will be a new principle in mining as far as this district is concerned, but will only be applicable to cases such as the Mikado where there is a flat-dipping ore chute, and the rest of the vein is not workable. Had there been any idea at the opening of the mine that the ore occurred as it does no doubt the method now about to be employed would have been originally adopted, and a great loss of time and money avoided. The present shaft cannot be used much longer anyway without re-timbering, as the present timbering is very poorly done and insecure. The new incline has been commenced in the 240 foot level at a distance of 381 feet from the shaft. A depth of 14 feet below the level was reached on Dec. 1, the date of my last inspection. Work in the new incline will be confined to sinking at present, and eventually the shaft will be completed above this to the surface, probably by the spring of 1900. A chamber about 14 feet cube has been excavated

in the level where the incline has been commenced for the installation of a subsidiary hoist.

A new steel wire hoisting cable one inch in diameter and 500 feet in length has been installed at the main shaft. An addition of 9 feet has been made to the dry and hoist house, and the hoist has been moved 15 feet further from the shaft. There is a small single-cylinder air hoist at the winze in the second level south. In sinking the winze a wire cable was employed to guide the bucket, instead of a skidway.

Some minor changes and additions have been made to the mill and cyanide plant. A new Blake crusher with 8 by 10 inch jaw opening has replaced the old one. In addition to the elevator a centrifugal pump has been provided for the elevation of the tailings to the charging tanks of the cyanide works. The elevator will be kept for emergency. Before the erection of the cyanide plant, the tailings from the mill being known to contain a considerable quantity of gold were damned up at the lake so as to be accessible in the future. A tramway has been constructed from this tailings dump to the cyanide building, and a small hoist and tramcar employed for conveying the tailings to the latter place, where they are diluted and mixed with the fresh tailings from the mill and sent up to the charging vats. There is also 400 feet of tramway extending from the cyanide works to the waste tailings dump at the lake, and one tramcar employed for conveying the material.

An addition has been made to the mill building for the sorting plant, the machinery of which had been ordered and was on its way at the time of my last visit. The Jenckes Machine Co., of Sherbrooke, Quebec, are supplying the plant. The principle in the sorting consists of first dumping all ore on a grizzly. The fines go to the mill directly, and what passes over the grizzly falls on a horizontal belt and is carried along towards a bin at the end. A man stands at the belt and rakes off all barren pieces, i.e., pieces that contain no quartz. As stated before, Mr. Pengilly expects to increase the bullion output by about 20 per. cent. by this plant. At present the mine is paying handsomely, the output, about $12,000 a month, being well maintained. Mr. Pengilly deserves considerable credit for the energy and ability which he has brought to bear in securing such a satisfactory state of affairs.

Previous to the past year Pennsylvania coal was burned in all the boilers at the mine. It was more expensive than wood, but more convenient. However wood has been burned this year, and will continue to be henceforth. A wood conveyor 400 feet long and capable of handling 10 cords per hour has been provided to take the wood from the barges and dump it on shore. A 6 by 6 inch vertical engine supplies the power. At the time of my last visit there were about 2,000 cords on hand, sufficient to last until the reopening of navigation, all wood being brought to the property by boat. A 40-light dynamo, with small vertical marine engine, is employed for lighting the mill and other surface works. A new dock with 50 feet of frontage has been built at a more convenient landing place. The old one is still used for passengers, etc. A building 20 by 30 feet in size for a general store has recently been constructed. A new Northey duplex pump has been installed at the second level in the mine, where a cistern 10 by 30 feet in area and 20 feet in depth has been excavated north of the crosscut from the main shaft. The main pump is stationed at the fourth level.

Instructions were left as follows :

1, Carefully scale the walls in all winzes and other parts of the mine, where men are apt to be passing through or working in. 2, Also, if the winzes are to be used for ascending and descending of men, construct a suitable ladderway in each ; and if they are to be used as ore-chutes, also construct a suitable division.

During previous winters, owing to the two connections with the surface, viz., the main shaft and the stope or open-cut, the cold current of air naturally generated under such conditions caused the formation of considerable ice in the shaft as there was always more or less water dripping down, and the mine was also made too cold for the men to work in. So instructions had been left to cover the open cut over securely to shut off the air entirely in the winter, leaving an air shaft which can be opened in the summer time for ventilation. Accordingly a row of stulls was placed at a depth of about 15 feet below the surface, and the space above filled to the surface with broken rock. At one place tailings was put in, and this was found to shut off all surface water entirely, whereas at other places the water leaked in all along. Owing to the severity of winters in this

country it seems impossible to keep open two shafts which are connected underground, as cold underground air currents and the formation of ice in the ladder ways and drifts are difficulties that always result. However, an air shaft is usually not required in the winter time, and can be covered over. Suitable stulls are provided in all working stopes. The ore is shot down on these, and mill-holes are carried up through the broken ore for the discharge of it to the cars below.

Mr. Pengilly wrote me under date of Feb. 15 as follows: The incline winze, 8 by 7 feet, is down 110 feet and drifting is started. The vein at this depth is in the hanging wall, thus giving us a better chance for drifting north, as the drifting will not interfere with the shaft. We intend to sink another 100 feet after this month. The reef is five feet wide and gives good values. Everything indicates that the vein is widening with depth. I have much pleasure in stating that the main shoot is widening to the south. The total depth of the mine to date is 300 feet vertically. Drifting: (Recent work) Fourth level, south, 596 feet. Fifth level, south, 4 feet.

The sorting plant is now completed. The ore as it is raised from the mine is trammed to the grizzly, the coarse ore falling into a bin capable of holding 40 tons. The ore is then passed through an ore gate to a table which is made of flat iron bolted to a sprocket chain that travels at the rate of 20 feet per minute. The ore is then conveyed to a Dodge crusher with 7 by 10 inch opening. From there it falls into an elevator, by which it is raised to a chute, allowing it to fall by gravity into the mill. The whole plant is worked by a 16 h.p. horizontal engine. The waste rock is picked by hand off the table and conveyed to the waste dump. Water washing of the ore has not yet been adopted, although thorough provision is made for its use. The plant is capable of sorting out 50 tons per day if required; it works very satisfactorily.

SIRDAR MINE.

The Toronto and Western Mines Development Company, Limited, has named its property, which adjoins the Mikado and consists of location 410D, the "Sirdar," and location S182, which also belongs to this company and occupies the northern part of the peninsula west of Bag bay, is known as "Sirdar Point." The Sirdar is now owned by The Sirdar Mining Company, a subsidiary company with the same personnel as the preceding company.

Theodore Breidenbach, formerly of the Mikado, is general manager of the Sirdar properties, and O. R. Smith is superintendent of the Sirdar mine. At the time of my last visit, Nov. 30, there was a total force at both properties of 41, of whom 14 were miners.

The main shaft is 200 feet deep. At a depth of 100 feet a drift has been driven south 17 feet and discontinued. At a depth of 200 feet a 5 by 7 foot drift has been driven south 111 feet and is being continued. At a distance of 8 feet from the shaft in this drift a 5 by 7 foot crosscut has been driven west 75 feet and is being continued.

The veins consist, as stated in previous reports, of a zone of altered granite 3 or 4 feet in width, which coincide with planes of faulting in the eruptive granite formation of the Mikado peninsula. There is usually a small stringer of quartz in the plane of faulting, and small stringers are also occasionally found in the altered zone or vein matter. More or less pyrites is found in the latter and it is said to contain gold all through, but I think it will make only a low grade ore. The quartz in the plane of faulting is often very rich, considerable visible gold being sometimes found in it. There are several of these veins; the shaft and the main drift are on one, and the crosscut at the second level is being driven to cut others parallel. One of these has been passed through at a distance of 40 feet from the commencement of the crosscut.

A Northey pump is stationed in a chamber north of the shaft at the 200 foot level. The ladderway in the shaft is suitably constructed to within 60 or 70 feet of the bottom; below this it is only temporary, no divisions or platforms being provided. Instructions were left to remedy this defect. A suitable guard rail has been provided at the first level, and also at the shaft mouth.

A one-half duplex Ingersoll compressor of three-drill capacity has been installed, with three No. 3 drills. A new 40 h. p. locomotive boiler has been placed alongside of and connected with the present 25 h. p. one; an addition has been made to the boiler room for this. A compressor room was also built.

On Oct. 23 I visited the mine and found the hoist in a dangerous condition. The brake was useless, the bucket being held by a wooden block inserted between the gear wheels. Such a condition of affairs was of course intolerable, and instructions were given to have the brake replaced by one suitable for the purpose. This had been done on the occasion of my next visit. It was also recommended that a bell rope 3-16 inch in diameter be employed.

A dock with 150 feet of frontage has been constructed on Bag bay. The company owns the steamer Josie, which plies between the mine and Rat Portage.

SIDAR POINT.

At Sirdar Point a 5 by 9 foot vertical shaft has been sunk to a depth of 23 feet, and is being continued to strike an ore body which was located by the diamond drill at a depth of 67 feet. The shaft is neatly and substantially timbered to a depth of 12 feet; hoisting is done by derrick and horse-power hoist; four miners are employed. The diamond drill has been working all summer on different veins on this property with reported good results, and is still in operation. Boarding camps and other necessary buildings, including a manager's dwelling, have been erected, and a dock constructed.

BULLION NO. 2 MINE.

Adjoining the Mikado and Sirdar properties is the Bullion No. 2 mine, consisting of locations D233 and 389, reached by a half mile walk from the Mikado, and owned by the Bullion Mining Company of Ontario, Limited. President, D. C. Cameron, Pat Portage; manager, R. Rogers, Rat Portage; head office, Rat Portage. Wm. Smaill is manager of the mine and John Harvey is mine captain. The total force at the time of my last visit, Dec. 1, was 20; number of miners, four.

Both trap and granite are included in the formation. There are three veins which exhibit distinct evidence of faulting, and are to a certain extent contact veins; two form a junction. All three are small but distinct. Felsite is associated with them to a certain extent.

Two shafts have been sunk 360 feet apart on different veins. No. 1 shaft is sunk a short distance from the junction. It has a cross-section of 5 by 7 feet, a dip of 70° northwest, and a depth of 75 feet. At a depth of 70 feet a drift has been driven south on the vein 22 feet. From the drift a crosscut has been driven west 53 feet, and from the end of the crosscut a drift has been driven 22 feet on a stringer. Hoisting is done by horse and whim, with bucket and pole skidway; the head frame is 11 feet high.

No. 2 shaft has the same dip and cross-section as No. 1; the depth is 112 feet. At a depth of 70 feet a drift has been driven south 10 feet on the vein. From the drift a crosscut has been driven west 50 feet, and from the end of the crosscut a drift has been driven south 15 feet. A diamond drill was in operation at the bottom of the shaft, boring east and west from the vein. A Lidgerwood reversible duplex hoist with 24 inch drum and $\frac{5}{8}$ inch steel wire cable has been installed. The bucket is dumped automatically at the surface. A neat head frame, 33 feet high, has been installed.

The drilling plant consists of a three-drill Ingersoll straight line compressor, a 3 by 6 foot receiver, and two No. 3 drills. The boiler is of 50 h. p. locomotive style; the engine and boiler house is 30 feet square. A short tramway and car are provided at the surface. The buildings consist of boarding and sleeping camps, storehouse, office, powder house, engine and boiler house, blacksmith shop and stables. The timbering of the shafts at the surface is neatly and suitably done. A ladder has been constructed in each shaft, but no division or platforms are provided with the exception of a short distance from the surface. Instructions were left to have this matter attended to, and also to provide a suitable guard rail at the mouth of each shaft.

Shortly after my last inspection Charles Brent of Rat Portage succeeded Mr. Smaill as manager.

IMPERIAL MINE.

The Imperial mine, situated about a mile southeast of the Mikado, consists of location D397, containing 54 acres. The regular landing is at the east end of Helldiver bay, from which a road of a half mile in length extends to the mine. A two-mile foot

trail connects the property with the Mikado. The owner is H. C. Symmes of Niagara Falls, Ont. Operations have been in progress since May 15, 1899. A. A. Hare is manager of the mine. The total force is 10, including eight miners.

The formation is trap. There are said to be five parallel veins within a distance of 110 or 120 feet; these are simply zones of quartz and greenstone, mixed; the quartz occurring in small stringers, and sometimes forming a definite vein.

A 5 by 8 foot shaft has been sunk on one vein to a depth of 70 feet. At a depth of 65 feet crosscuts have been driven north and south 9 feet each way and are being continued to cut the other veins. Hoisting is done by horse power, with a Colorado whim; a bucket is employed sliding on a pole skidway. The shaft is timbered for a depth of 23 feet; a ladder way extends to the bottom, but is not divided off from the hoisting compartment or provided with platforms as required by the Mines Act. Instructions were given to have this done. The shaft mouth is suitably fenced.

There is an old shaft about 50 feet east of the main one, on the same vein. It is said to be 50 feet deep, but is full of water. A number of small test pits have also been sunk on the property. The buildings consist of boarding camps, office, stables, shaft house, blacksmith shop and store house.

YUM-YUM MINE.

Two miners have been employed all summer doing exploratory work on the Indian Joe vein on the Yum-Yum property. I visited the property on Nov. 30, and saw a test shaft which had been sunk to a depth of 45 feet and discontinued. Another shaft was just commenced at a point where a small rich stringer of quartz was contained in the felsite. H. A. Guess is in charge of the work; Wm. Gordon is foreman. Mr. Guess informed me on Feb. 6 that the force had been increased to five.

LOCATION M 11.

On Nov 30 I visited M11, a location containing nearly 100 acres, and situated on the northwest shore of Helldiver bay. It belongs to Silas Griffis of Rat Portage, and has been bonded to J. B. Campbell of Montreal. T. R. Deacon of Rat Portage is superintending the sinking on two 50 foot shafts on the property. One shaft is being sunk close to the water on a 12 inch quartz vein containing iron pyrites and pyrrhotite. The walls are well defined and contain selvage. The country rock is altered trap; next to the walls it is schistose. The depth of the shaft is 12 feet and the cross section 6 by 8 feet. The other shaft is about half a mile north and is being sunk on a felsite dike which contains a vein of quartz mixed with the felsite to a certain extent, and ranging in width from 2 or 3 to 24 inches. This shaft is of the same depth and cross section. About 200 yards south of the preceding two costeans have been made across the dike, revealing a large body of quartz and felsite, mixed and considerably altered; copper and iron pyrites occur. The force consists of four miners; the work is done by contract.

TYCOON MINE.

The Tycoon mine is situated about three-quarters of a mile directly north of the Mikado, and the property consists of three small islands, D219, 221 and 222, and water lo ation JES54, circumscribing the islands. The owner is the Tycoon Mining and Development Company of Ontario, Limited; head office, Rat Portage. President, James Conmee, M.P.P., Port Arthur; secretary, M. Kyle, Rat Portage.

The formation of the islands is granite. There are no vein outcroppings, but the extension of the Mikado No. 2 vein is supposed to be on this property. Diamond drilling had been going on during the summer and winter previous to the commencement of sinking Several bores had been made; and according to the report of Mr. T. Breidenbach, who superintended the drilling, very satisfactory results were obtained.

A vertical shaft is being sunk on one of the islands, D219, to reach the ore body. It is $5\frac{1}{2}$ by $8\frac{2}{3}$ feet in cross section, and at the time of my last visit, Dec. 1, was said to be 78 feet deep. Work was suspended awaiting the arrival of a steam hoisting plant; so far windlass and bucket had been employed. A suitable ladderway has been constructed; but it is not divided off from the hoisting compartment. The shaft is timbered for a depth of 17 feet; the shaft mouth is suitably fenced.

P. S. Griffin is manager of the mine, and J. Downey is foreman. Buildings consist of boarding house, shaft and hoist house and blacksmith shop.

CROWN POINT MINE.

During the past summer operations have been carried on vigorously at the Crown Point mine, which is situated on the point east of the narrows between Bag bay and Clytie bay. The property consists of location D258, containing 106 acres. It is owned by the Crown Point Mining Company, Limited, with head office at 44 Canada Life, Montreal; capitalization, $1 000,000 in one dollar shares. President, Robert Bickerdike, Montreal; vice-president and managing director, R. H. Ahn, Rat Portage; secretary, E. A. Barton, Montreal.

The formation of the property is eruptive granite and altered trap. There are two classes of ore bodies; one consists of a large reef about 100 feet in width, situated at the contact between the granite and the greenstone; it is composed of altered granite and greenstone mixed. The structure is almost felsitic in parts. Small stringers of quartz occur, and the deposit is more or less charged with pyrites. Stripping and blasting have been done over the entire width at one point, and it is said that encouraging values were obtained. A shaft 8 by 16 feet in cross section had been sunk to a depth of 23 feet at the time of my visit, Dec. 1, and was being continued. A derrick and a horse power whim were employed for hoisting.

The other ore bodies, or veins as they are called, consist of sheared zones in the granite, similar to those of the Sirdar. Small stringers of quartz occur in the altered material, and visible gold is said to be found in them.

The main vein has a strike of a few degrees south of east. Two shafts are being sunk 200 feet apart on it. The main shaft is 8 by 16 feet in cross section, and is said to be 70 feet deep, with a cross cut at the bottom, 15 feet east; but it was full of water at the time of my visit, as the steam hoisting plant was being installed. There are two hoisting compartments and a ladder way. The shaft is neatly and substantially timbered with square timber that is said to extend to a depth of 30 feet. The head frame is 35 feet high, suitably braced and neatly constructed. The engine-house is nearly completed, the boiler and hoist being in place. The other shaft, known as the air shaft or "winze," is east of the main shaft, and sufficiently elevated to insure proper ventilation when underground connection is made. The cross section is 3½ by 10 feet, with neat collar; the depth is 47 feet, and sinking is being continued with windlass and bucket. There is a plane of faulting crossing the main vein about 100 feet west of the main shaft, and which is claimed to be an extension of the Mikado No. 2 vein. A test pit has been sunk 8 feet on it. A five-stamp mill is being erected on the northwest side of the point at a convenient situation with regard to the shafts. At the time of my visit all the machinery was on the premises, the building was completed and the boiler-house in course of erection. It is only intended as a test mill, as a plant of 100 stamps is in contemplation in the near future. Buildings consist of: Mill building, hoist house, blacksmith shop, powder house, boarding camps and private residence. There is a total force of 36, including 20 miners. W. Sharp is mine captain.

Mr. Ahn informed me that his company had altogether 23 locations in different parts of the district, and that for this property alone $15,000 had been arranged for as development funds.

He is also manager of the Gold Reefs Company, Limited, with the same head office as the preceding company. This company owns 26 locations in different parts of the district, and are developing at two different places; the Victory mine, consisting of locations McA41 and S48, east of Witch bay, on which a shaft has been sunk 25 feet and is being continued; and Gold Reefs No. 2, consisting of three locations in Clytie bay. A shaft has been sunk 10 feet on this property.

GREAT GRANITE PROPERTIES.

Operations were continued during the year on the property of the Great Granite Gold Mining and Development Company of Ontario, Limited. As stated in last year's report, this company owns 5,000 acres south of Echo bay, and prospecting operations have been in progress for about a year and a half on it. This past summer locations

northeast of the Crown Point mine were being prospected. The contact between the granite and the trap extends in a southwesterly direction through their property, occurring in a gulley almost entirely hidden by swamp. Work has been principally confined to prospecting this contact. Stripping and test-pitting have been done along the sides of the gulley, where the rock was elevated and samples assayed wherever anything suggestive of an ore deposit was found. At the time of my visit, Oct. 12, a test pit had been commenced on the side of this gully where a stringer of quartz was exposed. It was of course inadvisable to make any serious attempt to get at the contact through the swamp, and the company intended to do any further testing or prospecting with the diamond drill.

The superintendent of the work is S. H. Reynolds; assayer, B. L. Thorne. Six miners had been employed all season, but there were only three at the time of my visit. The camps are on Clytie bay. These consist of tents on shore for the men, and a house-boat which served as general boarding camp, dwelling for manager and assayer, general office and assay office. The house-boat is an innovation for this purpose, and, although a little more costly than rough camps on shore, is more comfortable and can be moved from place to place according as the scene of operations change. It can be recommended to parties who intend doing prospecting work on a small scale on almost any property on the Lake of the Woods, or other body of water which gives access to a number of properties. In case of the abandonment of the property the house-boat, being movable, is not a useless asset as fixed camps usually are.

CAMERON ISLAND MINE.

After nearly a year of idleness, operations have been resumed at the Cameron Island mine since the latter part of the summer. The company has been reorganized, although no change has been made in the name. The present officers are: President, Dr. Joseph Fowler, Buffalo; vice president, Thos. Milburn, Toronto; secretary, Harry Vars, Buffalo; treasurer, H. J. Brain; head office, Toronto. The manager of the mine is A. D. Lord, and the foreman Geo. Thurber. As mining operations had not commenced at the time of my inspection, Oct. 11, the force consisted of only a few men employed in surface work. A one-half duplex Ingersoll air-compressor of three drill capacity has been installed, with three machine drills, a receiver and 40 feet of 3-inch conductor pipe. A new 80 h.p. return tubular boiler has been placed along side of and connected with the previous one of 25 h.p. New frame buildings have been erected, consisting of the following: Engine- and boiler-house, 40 by 40 feet; foreman's dwelling and office, manager's dwelling and general office, assay office and carpenter shop. The latter is provided with a 6 h.p. engine for operating the machinery therein. An addition has been made to the dock on the south side of the island, giving it a frontage of 60 feet.

NORA MINE.

On Oct. 20 I visited the Nora mine, which consists of locations JES38, 41, 42 and west half of 39 and JO79 and 80, aggregating about 200 acres. It is situated in the northern part of the Western peninsula, Lake of the Woods. The steamboat landing is at the foot of a small bay on the south shore of Ptarmigan bay, and about 15 miles from Rat Portage. There is a good portage of about 200 yards into Fox lake, over which a canoe trip of 1½ miles must be made to the mine landing, which is connected with the mine by a road 1½ miles in length. The property is owned by The Gold Leaf Mining Company, Limited; and the head office is 32 Ontario Chambers, Ottawa. President, Hon. Dr. F. W. Borden; vice president, Hon. Senator Clemow; sec-treasurer, A. Simpson; managing director, A. T. Mohr, 812 Prudential Building, Buffalo, N. Y. Robert Laird, M.E., is manager of the mine, and Ed. Hamill is mine captain. The total force is 17, of whom 10 are miners. The formation is trap. Large granite dikes, merging into porphyry at the sides, occur at several places on the property. Stripping and test-pitting have been done on some of these, where veins or stringers of quartz occur. The main vein occurs in a dike of felsite, or fine grained granite, which has a strike of north 70° east. It is traceable in this dike over adjoining locations in both directions, and it is said to extend for miles.

On location JES38 a shaft with a dip of 79° north has been sunk on the vein to a depth of 120 feet and is being continued. The cross section at the surface is 4 by 7

feet, and lower down 6 by 10 feet. At a depth of 72 feet the vein appears to split ; one branch bending to the north, with a dip of 45°, and the other continuing straight. The north branch was followed for 25 feet by an incline, showing a good hanging wall with selvage. The vein in this incline is well defined. The shaft had subsequently been continued on the other branch, maintaining the same dip as above. The width of the vein underground ranges from 1 to 4 feet. The first level is at a depth of 72 feet ; a 4 by 7 foot drift has been driven east 49 feet. The pump, a Northey, size 5 x 7 x 12, is stationed at a depth of 90 feet, in a chamber at the entrance to the incline, and the latter is used as a cistern.

The hoisting plant consists of double drum duplex Waterous hoist, 25 h. p., return tubular boiler, steel wire cable, bucket, pole skidway and a head frame 30 feet high, substantially constructed. There is 100 feet of tramway on the surface, with one iron self-dumping car. Smoke and gases resulting from blasting are cleared out of the shaft by live steam. The shaft timbering extends for a depth of 45 feet on the ends and hanging wall, and for 30 feet on the foot wall. The mouth of the shaft is properly fenced, and provided with inclined trap doors, which are closed when dumping. A ladderway has been constructed to the required depth, and is in suitable condition, with the exception that it is not divided off from the hoisting compartment. Instructions were given to have this done. Blasting is done by battery in the shaft and by fuse in the drifts. The following buildings are on the property : Cooking and sleeping camps, blacksmith shop, engine house, 24 by 24 feet, powder house and stable.

On the adjoining location to the east, which does not belong to the company, a shaft said to be 30 feet deep, but partly full of water, has been sunk on the vein or dike at a distance of 600 feet from the Nora shaft.

MANITOU LAKE REGION

It seems strange that the Manitou country has not been more successful in securing its share of the progress of the district in the past. It is not so accessible as the Lake of the Woods, but is more so than some parts of the district which are going ahead favorably. There is a regular steamboat service on Wabigoon and on Manitou lakes ; three steamers on Wabigoon lake and two on the Manitou. There is also a stage (an ordinary wagon) on the seven-mile portage. The road is usually in fairly good condition if the season is not wet. Probably the fact that stamp mills are coming in will make a difference, and give an impetus to mining in this region. Comparatively little work was going on early in the summer, but later several new properties were put under development, and prospects for a good future were much improved. There is a formation of felsitic schist, which occurs in the green schist, and appears to extend all down the Manitou. It is more or less filled with stringers of quartz in varying quantities, and in some places quartz veins of fair size occur. Most of the working mines are in this formation, which apparently carries gold all through, the richest portions being the places most heavily impregnated with quartz. From all appearances the Manitou will prove to be a region of large low-grade propositions.

OXFORD MINE.

The Oxford mine consists of locations SV128, 129, 131 and 166, situated about a mile west of Gold Rock on the Upper Manitou. The property is owned by Messrs. Thos. Armstrong, Wm. Pinkerton and Wentworth Sharp ; and it is under operation by the Oxford Mining Company of Toronto, Limited, who get a certain interest for the expenditure of a certain sum on development work. The president is Wm. Pinkerton ; secretary, John F. Gray ; head office, 80 Bay street, Toronto. Thos. Armstrong is manager of the mine ; total force, nine ; number of miners, four. The formation is green schist. The ore body is a reef consisting of the schist filled with stringers of quartz. On SV129 a shaft 6 by 8 feet in size has been sunk 77 feet in the centre of the reef, with crosscutting at the bottom north and south 13 and 11 feet respectively. Date of last inspection, Oct. 6. Buildings consist of boarding camps, blacksmith shop and stables.

ORION MINE.

On Oct. 8 I visited the Orion mine, on my return trip up the lakes. This property is situated southwest of Charlton lake, which is west of the narrows between the Upper and Lower Manitou lakes. It consists of seven locations, HP357, HW88, 49, 50 and 51 and G151 and 460; owned by the Orion Gold Mining Company, Limited, of Rat Portage, Ont., capital, $999,999, in one dollar shares; head office, Rat Portage, Ont.; branch office, 318 and 319 Germania Life Building, St. Paul, Minn. Geo. H. Fullerton of Rat Portage was president, and H. C. Peterson of St. Paul secretary at the time of my inspection; but I was told by the president that the company was to be reorganized and the new officers were not appointed at the time of writing. The ore body consists of a band of schist which is more or less filled with stringers of quartz. In some places the schist is quite heavily impregnated with quartz; these are the richest portions. What is called the vein or pay streak is a zone of the schist filled with quartz stringers. The strike of the schist is northeast and southwest. A shaft 6 by 10 feet in size, with a dip of 60° to 70° southeast, has been sunk on the vein to a depth of 50 feet, and is being continued. The work is being done under contract by Alex. Gordon,; three miners are employed. Newton Higbee, the vice-president of the company, is manager of the mine. The only building is a boarding camp.

INDEPENDENCE MINE.

The Independence mine, mentioned in last year's report as the "Westerfield" mine is the adjoining property to the Orion. Operations were suspended at the time of my visit, owing I believe to a lawsuit which had been pending for some time regarding the title to the property. No work had been done in shafts No. 1 and 2 since last year's report. The main shaft, on No. 3, was also partially full of water, preventing ingress. But Mr. Gordon, who had been in charge previous to the suspension of operations, informed me that a depth of 85 feet had been reached, and that a crosscut at the bottom passed through a width of 38 feet of ore. The mine will likely be in operation again soon. All the machinery for a 10-stamp mill was on the road between the railway and the mine. The greater part was at the mine landing, which is on the south shore of Little Manitou lake, from which point a good wagon road extends to the mine.

GLASS REEF.

The Glass Reef property consists of locations HW391 and 594, containing 40 acres each, situated on the mainland south of Beaverhead island on the Big Manitou lake. It is owned by Messrs. Geo. W. Glass, E. H. James and A. P. Buchannan, who are organizing into a company to be called the Glass Reef Gold Mining Company of Manitou Lake, Limited, with a capital of $750,000; par value of shares, 50 cents.

The ore body is a large reef of fine grained schist, which weathers grayish white, and in some places reddish brown, due to pyrites. Granite occurs on the west side of the reef, and trap on the east. The reef contains stringers of quartz, and in some places quartz veins, and is full of latent cracks and seams. A shaft 6 by 12 feet in size has been sunk to a depth of 14 feet on the reef and is being continued. Hoisting was done by horse power at the time of my visit, but a steam hoist was on the way and will be installed at once. An air compressor is also on the way. Camps are being erected. The total force is 14; number of mines, 12. Geo. W. Glass is manager and James McGillivray foreman. Date of inspection, Oct. 7.

ADJOINING LOCATIONS TO GLASS REEF.

I walked over to HP267, an adjoining location, said to belong to V. Quackenbush, and found the continuation of the reef, with an 8 foot test pit, in which sinking was in progress. On HW595, another 40 acre location adjoining on the west, a test pit had been sunk 15 feet on a large out cropping of quartz, which has the appearance of a vein lying almost flat, and about 10 or 12 feet in thickness. The country rock is massive greenstone. The location is owned by Messrs. Glass, McGillivray, Buchannan and James.

BARKERS' MINE.

Barker Bros.' mine consists of location HW339, situated northwest of the Lowe Manitou lake. The landing is near the upper end of the long bay which extends north from the southwestern part of the lake. The mine has not been in operation since early in 1899, and there was only a caretaker on the property at the time of my visit. The formation is greenstone. Small irregular veins of quartz extend through the property. A shaft had been sunk to a depth, said to be 62 feet, with drifting at the bottom and overhand stoping, but it was full of water. At a short distance from the shaft an open cut had been made along the vein 100 feet long, 3 feet wide and about 4 feet deep. Stripping and blasting had been done at other points also. The shaft is about a mile from the lake, where a Tremaine two stamp mill has been erected, which was in operation for some months during the winter previous to closing. The other machinery consists of a Gates crusher, a horizontal engine for the crusher and a return tubular boiler. A wagon road has been constructed from the shaft to the mill. Boarding camps and other buildings have been erected.

LOCATIONS BEYOND BARKERS' MINE.

About two miles beyond Barkers' mine is HW515, a location of 118 acres owned by Messrs. D. C. Petrie, A. H. Creighton and H. E Price. An open crosscut 8 feet deep was being made through an outcropping of quartz 24 feet wide in a formation of greenstone. Other veins were observed on the property, on which a little work has been done. A 2 foot vein of promising looking quartz was observed in a band of felsite schist. Camps were being erected on the property. The total force was nine ; number of miners, six.

CRACKER JACK MINE.

The Cracker Jack mine is situated on the south shore of the long arm (known as the "Manitou Stretch") of the Lower Manitou lake, about 10 miles from the main body. It is owned by the Cracker Jack Gold Mining Company, Limited. Walter J. Keating of Fort Francis was manager of the mine while it was in operation, which was for a few months during the summer. The formation is a fine grained schist, which weathers white and brown. The veins consist of zones impregnated with stringers of quartz. I walked over the property alone, as no one was there at the time of my visit, Oct. 7, and found two shafts 40 and 45 feet deep on different veins. Mr. Keating informed me in writing that a third had been sunk 19 feet.

NEW KLONDIKE REGION.

Comparatively little work has been going on in the New Klondike during the year. Most of the property owners are either waiting to sell, or else waiting the results of development work on properties in actual operation, before deciding upon the expenditure of money upon their own.

Early in the year I visited NT20, a location about 12 miles north of Dyment, for the purpose of investigating an accident which occurred there on March 28, 1899. A vertical shaft has been sunk 80 feet in the hanging wall of a large quartz vein. Work was discontinued later on in the season.

A little prospecting work was done on several other properties in this region, but they were not visited. Thos. Hogan informed me that he sunk 17 feet on location H W 434, belonging to him on Long lake. The vein looked very well, was of considerable width and gave encouraging assays.

Two properties were being worked near Tache on the C. P. R., but I did not visit them. I was told a shaft had been sunk 80 feet on one of them.

GOLDEN WHALE MINE.

Munroe and Watson's mine, HW416 in the New Klondike, is now known as the Golden Whale. This property has been in steady operation during the year. Three

shafts have been sunk, but only one was in operation at the time of my inspection, Feb. 17. I got the following measurements from the manager, in connection with No. 1 and No. 2 shafts, which were full of water: No. 1 shaft, depth 105 feet; crosscut at bottom, 15 feet southeast. No 2 shaft, 470 feet north east of No. 1, on a different vein, depth, 105 feet; at depth of 60 feet a crosscut 5 feet northwest. No. 3 shaft is 200 feet southwest of No. 1 on the same vein. The depth is 80 feet. At a depth of 75 feet there is 29 feet of drifting in each direction along the vein, which ranges in width from 1 to 4 feet in the drifts. The ladderway consists of ladders suspended from the surface, without any division or platforms. Instructions were given to remedy these defects, and also to fence this and the other two shafts. The hoisting plant consists of a small steam hoist, vertical boiler, wire cable, bucket and pole skidway. Each shaft is provided with a suitable head frame.

There is an open cut on the main vein extending northeast from No. 3 shaft for a distance of about 500 feet, with an average depth of about 7 feet. Instructions were given to fence or fill the open cut. At a distance of half a mile from the shaft a mill has been erected on the bank of a small river and the following machinery installed: A Tremaine two-stamp mill, with apron plate and gyrating amalgam plate, a No. 1 Gates crusher, Frue vanner with 6 foot belt, 35 h p. boiler, 16 h.p. engine and pump. The buildings on the property consist of mill building, temporary hoist house and blacksmith shop, store house, boarding camps, stables, manager's dwelling and two private dwellings. The manager of the mine is John M. Munroe; mine contractor, Thos. Hogan; number of miners, 10; total force, 21.

LOCATION SV105.

Two or three properties in the Lake Minnietakie region north of Dinorwic have been worked to a small extent during the summer. I did not visit this locality, but got some notes from parties operating there.

Location SV105, known as the Sykes mine, is the most extensively worked property. It was originally owned and operated by a syndicate from eastern Ontario, but the syndicate have formed into a company, the John Sykes Mining and Milling Company, Limited; capital, $500,000 in one dollar shares; head office, McKinnon Building, Toronto. President, John Sykes, Glen Williams, Ont.; vice-president, John Shilton; secretary, W. H. Wallbridge. Work has been going on at the mine since the winter of 1897-98. I was informed by G. H. Fanning, the manager, that the shaft had been sunk to a depth of 108 feet. At a depth of 57 feet a crosscut has been driven east 14 feet, and one west 21 feet. At the bottom of the shaft a crosscut has been driven east 42 feet and one west 70 feet. The machinery for a 10 stamp mill is on the property, and partially set up. A total force of 12, including 8 miners, was employed while the mine was in operation. On Feb. 12 two miners were killed by an explosion in a test pit about 300 feet from the main shaft, and work was suspended with the probability of not being resumed for some time.

OTHER MINNIETAKIE PROPERTIES.

Mr. D. W. Black of Dinorwic has been manager of several properties in the Lake Minnietakie region during the year; and he gave me the following notes on them:

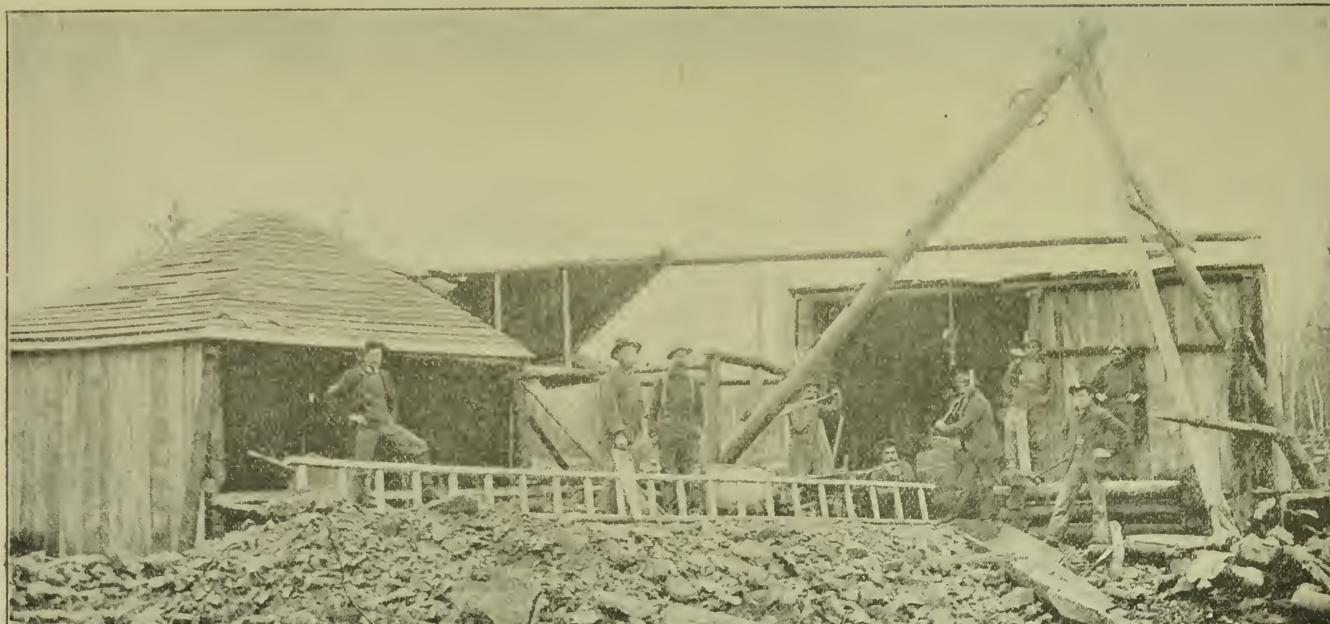
Location HW113; area, 40 acres; situated on east shore of Pelican lake; owners, a syndicate composed of Toronto capitalists. Work had been going on for 2½ months during the fall of 1899. Five miners were employed test-pitting. The Golden Rod Mining Company of New York sunk a 40 foot shaft on a location on Teresa lake southeast of Minnietakie.

LOWER SEINE REGION.

Notwithstanding the disastrous effect upon the mining market of the uncertainty regarding the Golden Star, splendid progress has been made in this locality during the year. About a dozen properties have been under substantial development for the greater

17. Main Shaft of Crown Point Gold Mine, before Shaft House was erected, p. 59.

18. Mill, Shaft House, etc., of Crown Point Gold Mine, p. 59.

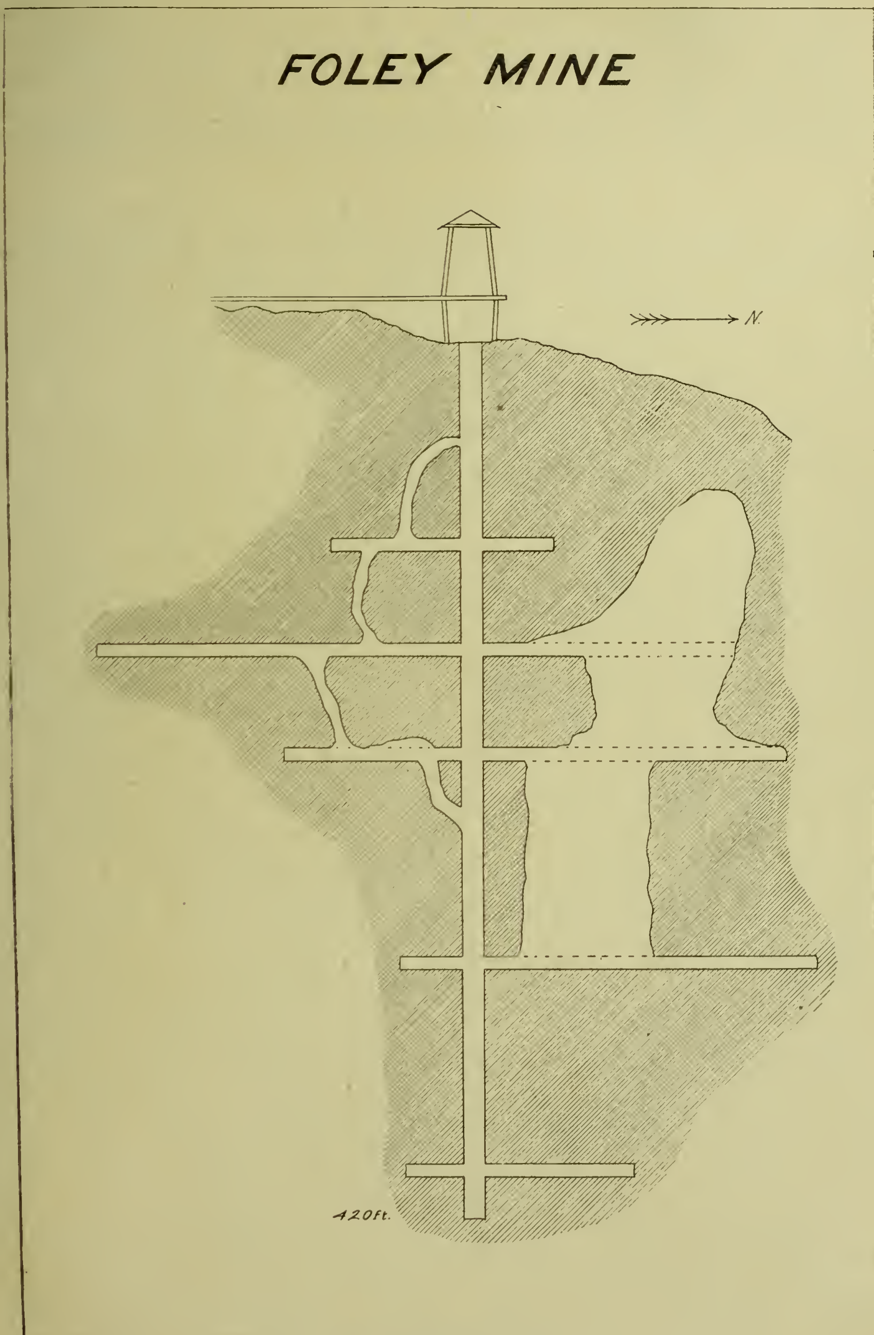


19. Imperial Gold Mine, Shoal Lake, p. 57.

20. Cameron Island Gold Mine, p. 60.

21. Shaft and Engine Houses of Cameron Island Gold Mine, p. 60.

part of the time, and in most cases by genuine companies who are not working for mere speculative purposes. It appears that a more substantial class of men who have



Scale : 90 feet=1 inch.

money to spend are now recognizing the possibilities of the district, and are doing legitimate development work accordingly.

FOLEY MINE.

There have been continual reports of the sale and the reopening of the Foley mine ever since its closing down of May 20, 1898. It has at last been sold, and hearing that work was to be commenced I wrote to Mr. O. B. Robinson, the manager of the mine, and received a letter from him under date of Feb. 13. The new company is the Canadian Mines Development Company, Limited; head office, St. Stephen Chamber, Telegraph Street, London, England. The force will not exceed 20 at present. Work will be commenced in No. 5 shaft, sinking, drifting and crosscutting to develop the ore body. Work was to have started in about 10 days from the date of the letter.

GOLDEN STAR MINE.

The Golden Star mine has been the central figure among western Ontario mines during the past year and for some time previous. The geology of this mine has been sufficiently dealt with in previous reports, and hence need not be gone into here. Before any work was done on the property there was little showing to encourage the expenditure of money. It is said to have been condemned by several experts who examined it. However Mr. Lewis A. Hall, a wealthy American mining man, owned a large number of shares in the company, and supplied the capital to develop the property and erect a mill. Results were not very encouraging until after the first level was passed, which is at a depth of 75 feet. Prospects brightened from then on, and the property looked well. The shaft was sunk to a depth of 376 feet, and four levels established with an aggregate of about 700 feet of drifting. These developments revealed a rich chute of ore about 100 feet in length and from 2 to 12 feet in width, extending through all the workings from the surface down. Systematic assay work showed where the best ore lay. A 10 stamp mill was erected, hoisting and tramming plants installed, and development work in the mine suspended. The history of the mine and the company from this on is evidence of the policy which the American owners had deliberated and successfully carried out. Under the belief that the best ore had pinched out at the bottom, and that hence the end of the mine was in sight, they proceeded to bull the price of the stock with a view to unloading to the best advantage. Accordingly, development work in the mine was practically discontinued at this stage. The company had then to start with, a developed mine, all the ore being blocked out but none stoped, a large dump of ore on the surface resulting from development work, a well-equipped mill and an economical tramway between the mine and the mill. Expenses were cut down in every possible way, the best ore taken from the mine and the dump, and thus a large bullion output secured at a minimum of expense. When Mr. Hall advanced the original money to develop and equip the mine an agreement was made by which he was to be repaid by the first products of the mill. Instead of taking payment in this way Mr. Hall allowed the product to go towards paying dividends, and was remunerated by receiving additional stock, which was increased from 1,000,000 to 1,200,000 shares, the increase going to Mr. Hall. Before the stock was increased monthly dividends of 1 per cent. were declared until the stock had risen to what was considered the maximum, which was a little over 80 cents, the par value being one dollar. The stock fluctuated between 70 and 80 cents for some time, and the largest shareholders were at this time unloading, as the mine had been gutted of its best ore. Toronto capitalists bought in (the stock having been originally held almost entirely in the United States) until they obtained a controlling interest. The head office was then moved from Duluth to Toronto, and the company was reorganized. The officers at present are as follows: President, Hon. S. C. Wood; secretary, N. C. Neff; treasurer, H. H. Wood. As the mine had been despoiled of its best ore, and there was no development work ahead, the company could not continue to pay dividends, so they bent their energies towards developing the mine and placing it in condition for permanent work. R. A. Kerr, the superintendent of the mine, resigned, and R. H. Flaherty, who has been for several years connected with mining in western Ontario, was appointed manager in July, 1899. Development work was delayed for some time after Mr. Flaherty's appointment, pending the arrival of auxilliary hoisting machinery for sinking in the main shaft. However this arrived early in August, and from that time development work has been pushed continuously. The following were the underground measurements at the time of my last inspection, Oct. 29:

			feet.
First level	North drift		107
	South	"	101
Second level	North	"	144
	South	"	131
Third level	North	"	149½
	South	"	46⅔
Fourth level	North	"	207
	South	"	14
Fifth level	North	"	39
	South	"	26
Sixth level	North	"	36½
	South	"	35½

The fifth level was driven at a depth of 357 feet and the sixth at a depth of 430 feet.

Winzes and upraises : At a distance of 100 feet north of the shaft a winze connects the first and second levels. An inclined raise has been made from the end of the fifth north to the fourth, breaking through to the latter level at a distance of 100 feet from the shaft. At a distance of 50 feet south of the main shaft the stope from the first level has been broken through to the surface, forming an air shaft.

Crosscuts : In the third level north, at a distance of 54 feet from the shaft, a crosscut has been driven east nine feet and discontinued, and at a further distance of 46 feet another has been driven west 5½ feet and discontinued also.

Stoping, first level, north : length of stope, 22 feet ; height above roof of drift 15 feet ; width, three feet. South : length of stope, 65 feet, leaving shaft pillar, 6 to 30 feet long ; height, raised to within several feet of surface ; width, 3 to 7 feet.

Second level, north : length of stope 40 feet, leaving shaft pillar four feet long ; height, raised to within about 5 feet of first level ; at height of 52 feet above level the stope is broken through to shaft, with opening three feet square ; width of stope, 3 to 9 feet. South : length of stope, 55 feet ; shaft pillar 4 feet long ; height, raised to first level ; width, 3½ to 6½ feet. Third level, north : length of stope, 100 feet ; shaft pillar 4 to 30 feet long ; height, raised to second level ; width, 2 to 10 feet. South : no stoping. Fourth level, north : length of stope, 80 feet ; shaft pillar, 30 to 50 feet long ; height, raised to third level ; width, 2 to 4 feet. South : no stoping. Fifth level, north : stoping commenced in inclined raise. South : no stoping. At a distance of 300 feet south of the main shaft a test pit has been sunk 22 feet on a branch of the main vein. It was the intention of the manager to drift south from the second level to this pit, in the hope of striking a valuable chute of ore. The vein pinches at the bottom of the shaft, but widens again in the drifts at the sixth level. At the end of the south it is 2½ feet wide, with walls rather indefinite. At the end of the north it is 20 inches wide, with good walls. The drainage of the mine is effected by pumps at the fifth and third levels. There is a considerable quantity of water coming down the shaft, but most of it is caught at the third level. No change has been made in the drilling and air compressing plant. The skip road has been completed to the fifth level, where a suitable timber pentice is provided, and a small auxiliary hoist installed for sinking. The dip of the shaft is practically uniform from the first level down. A new ¾ inch crucible steel wire hoisting cable 650 feet long has been installed.

Fifty feet of tramway connects the shaft with a new ore chute, which has been constructed at the loading terminal for the purpose of keeping the various grades of ore separate. The tramway buckets are loaded from gates at the bottom of the chute. Ten buckets are in use. No change has been made in the mill. As stated in the preceding report, the mine had been left in poor condition by the old company, but under the new management it is being improved with reasonable expedition. The ventilation in the summer time was poor, but since the air shaft has been opened up and winze connection made between all the levels (except the sixth) there has been an improvement in this respect. In the second, third and fourth levels drifts under stopes have been roofed over with suitable stulls and lagging. Instructions were left to do likewise in other parts of the mine where work was in progress. Owing to irregularities in the shaft a straight skip road could not be constructed, and consequently the skip would sometimes leave the track ; so instructions were left to provide suitable back-timbers to prevent this. The ladderway is suitably constructed as far as the fifth level, with the exception that the portion between the fourth and fifth levels has not been cased off from the hoisting compartment. There was no ladderway below the fifth level. Instructions were left to

supply these deficiences. The captain of the mine is E. J. O'Brien, and the mill superintendent is George Verry. At the time of my last visit there was a total force of 55, including 24 miners.

I received a letter from Mr. Flaherty under date of Jan. 4, from which I extract the following: "Regarding the measurements in the mine, I would state that the shaft is now 480 feet in depth, and we are about to open up the seventh level at the 500 foot mark. The sixth level is driven to the north a distance of 71 feet, and to the south a distance of 35 feet, making the opening, including the shaft, on the strike of the vein about 116 feet. The fifth level to the south has been driven 43 feet, and the fourth to the north has been driven 224 feet from the shaft. The shaft is completely equipped with ladderway, division, etc., and we are now running the skip to the sixth level. I would state that all headings and the bottom of the shaft, so far as new development work shows, are in ore. I am handicapped for want of skilled miners, and cannot push the drifting on the different levels as fast as I would wish. The sinking is going on fairly well."

RANDOLPH MINE.

The Randolph mine consists of location AL115, a 40 acre location adjoining the Golden Star on the west. It is owned by the Randolph Gold Mining Company of Ontario, Limited. The formation is an extension of the Golden Star and JO41, being composed chiefly of massive greenstones, felsite, etc., with conglomerate on the southern half of the location. The vein is traceable about 500 feet, and varies in width from a few inches to three or four feet. The main shaft is 6 by 8 feet in cross section, and was 95½ feet deep on Oct. 29, the date of my last inspection. At a depth of 85 feet a drift has been run east 21¾ feet and one west 34 feet. A No. 5 Cameron pump is stationed in the latter drift, in which a 5 foot cistern has been sunk. The shaft is timbered for a depth of 18 feet and a suitable ladderway constructed. A small duplex hoist has been installed, with suitable head frame and return tubular boiler. At a distance of 100 feet east of the shaft a test pit has been sunk 3 feet, and 300 feet west of the shaft another has been sunk 11 feet. The buildings consist of engine house and dry, blacksmith shop and boarding camps. Neil Berger is manager of the mine. The total force is 17; the number of miners 12.

ISABELLA MINE.

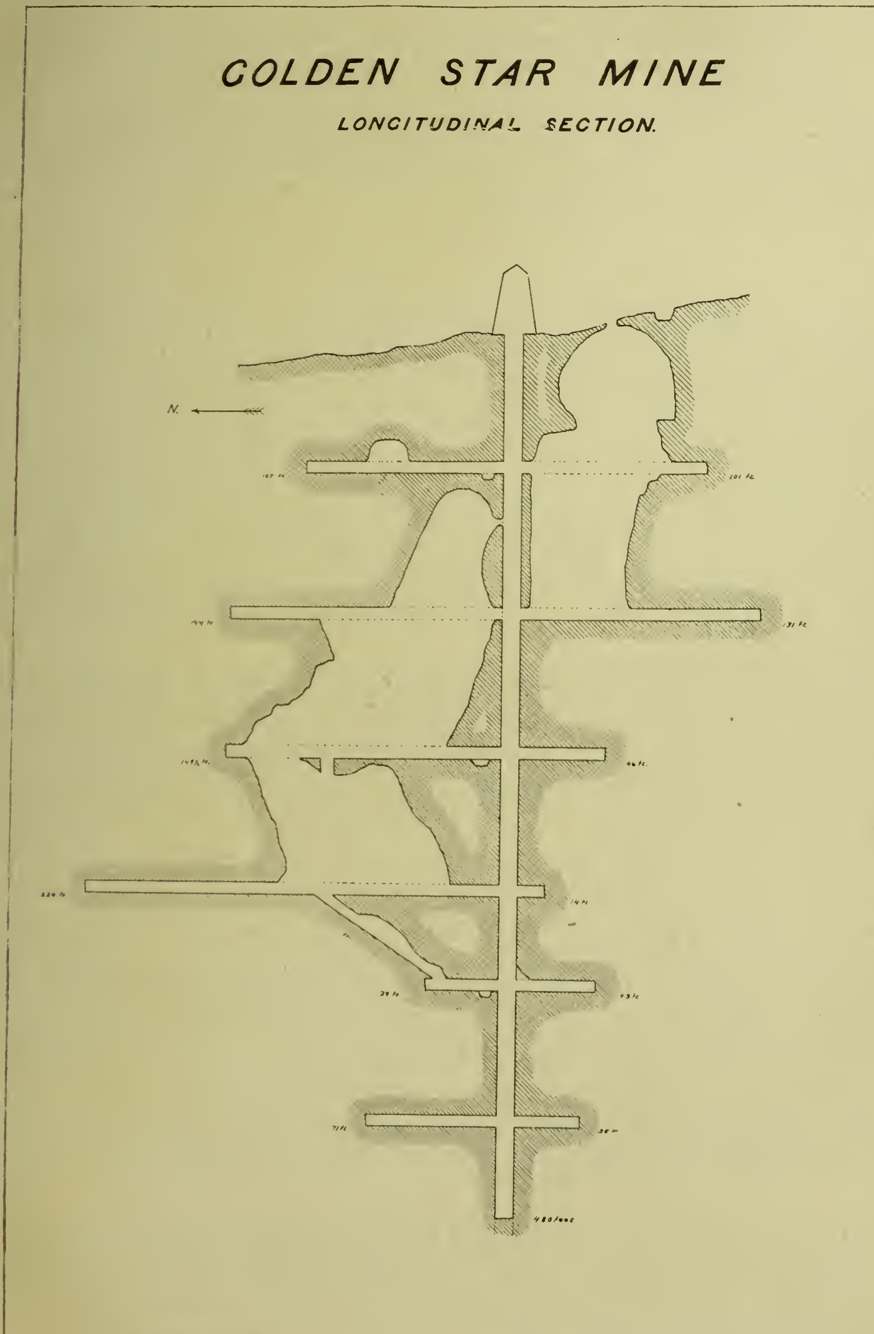
Operations have been in progress since early in the summer on AL113, a 40 acre location adjoining the Golden Star on the east, and known as the "Randolph Farm," as there is an area of several acres on the location which is soil, covered and under cultivation. The property has been bought by a company from Messrs. Berger and Randolph. The formation is similar to that of JO41. The vein is a well defined quartz body, from 2 to 10 feet wide, and traceable for five or six hundred feet, with a strike of north 15 or 20 degrees west. Over 200 feet of the vein has been stripped. The quartz is bluish white in color, and contains copper pyrites, galena and zinc blende. Values are said to be encouraging. At one point a test pit has been sunk to a depth of 10 feet, showing 3½ feet of vein with good walls quite free from the vein matter. At a distance of 300 feet northwest of this pit a 6 by 8 foot shaft has been sunk to a depth of 52 feet (and is being continued) on the junction between this vein and another. There is 6 by 8 feet of vein on surface, with well defined walls. The work is in charge of Neil Berger, who has a force of three miners and one surface man.

DECCA MINE.

The Decca mine has been in steady operation during the year. Daniel Morrison is now manager. The total force is 12, of whom six are miners. No. 2 shaft was full of water on each visit, and has not been in operation since early in the year. It is said to to be 110 feet deep, with drifts started in both directions along the vein at a depth of 100 feet.

Work has been confined entirely to No. 1 shaft since the closing of No. 2. The vein here is much smaller, averaging probably a little over a foot, but quite rich. Much visible gold is found in it. The quartz is variable in color and is mostly dark, containing galena, zinc blende and copper and iron pyrites. The depth of shaft was 210 feet on Oct

27, the date of last inspection. At a depth of 100 feet a drift has been run 25 feet south-east along the vein, and a 15 foot cistern sunk in it. The pump, a No. 5 Cameron, is



Scale: 105=1 inch.

stationed here, and work discontinued at this level, it being used entirely as a pumping station. At a depth of 200 feet the second level has been established, with drifting com-

menced along the vein. The first half of an Ingersoll duplex compression has been installed, with a 4 by 10 foot receiver and three No. 3 drills. Hoisting is done by a Lidgerwood duplex hoist, $\frac{3}{4}$ inch steel wire rope and bucket, sliding on pole skidway, and dumping by mechanism similar to that of the Manhattan, described farther on. The boiler is a 65 h.p., return tubular. The ladderway is suitably constructed as far as the first level. Below this suspended ladders are employed. Several broken rungs were found. Instructions were left to construct the ladderway according to the Mines Act and replace broken rungs. A suitable guard rail has been provided at the shaft mouth. The brake on the hoist was found to be improperly adjusted, so that a bucket of rock could not be held by it. Instructions were left to remedy this defect. The buildings on the property consist of two shaft houses, boiler and hoist house, 32 by 40 feet, two blacksmith shops, office and boarding camp.

LUCKY COON MINE.

The Lucky Coon is one of the oldest properties in the Lower Seine country. Some years had elapsed since it had been in operation some time previous to the present resumption of activities. It was originally owned by A. M. Robertson, the present manager, and others. At the time of its former operation it was under option by a company. A five stamp mill was erected and several shafts sunk on the different veins, the ore from which was being treated. But a disagreement arose between the owners and the operators, and as a result work was suspended and remained so until early in the summer of 1899, when the present company, the Lucky Coon Gold Mining Company, bought the property, and have been operating it since. The head office of the company is Keystone Block, West Superior, Wis ; capital, $1,000,000 in one dollar shares. President, J. S. Hillyer ; first vice-president, Geo. H. Hillyer ; second vice-president, W. J. Keating, Fort Francis, Ont.; secretary-treasurer, Carroll Corson, Duluth The property consists of location 655 P, containing 147 acres, and situated about $2\frac{1}{2}$ miles north of Mine Centre, on the Government road.

The formation consists of protogine, and contains a number of well defined quartz fissure veins. Four shafts and several test pits have been sunk on the different veins. No. 1 shaft is said to be 50 feet, but has not been in operation since the re-opening of the mine. No 3 shaft is said to be 24 feet deep, but has not been in operation since the re-opening. No. 5 shaft is said to be 78 feet deep, but on the occasions of my visits of inspection it was temporarily closed down, and contained water to within 35 or 40 feet of the surface. The dip is nearly vertical, and the cross section 5 by 7 feet. A ladderway has been properly constructed and cased off from the hoisting compartment as far as the water level. Timbering extends for a depth of 21 feet. A suitable guard railing has been provided at the shaft mouth.

No. 2 shaft is 4 by 6 feet in cross section, and 108 feet deep. It is sunk on the vein, which has a nearly vertical dip. Drifting has been commenced at a depth of 100 feet. The shaft is timbered for a depth of 5 feet, and lagged for a depth of about 22 feet below this. A suitable guard railing is provided at the mouth, and a proper ladderway has been constructed. The hoisting plant consists of a small Ingersoll duplex hoist, $\frac{5}{8}$ inch steel wire cable, steel bucket, pole skidway and 30 h.p. locomotive boiler. An iron self-dumping car and short tramway are provided on the surface.

The vein on which No. 2 shaft is sunk is of considerable width and well defined. There are parallel veins on both sides ; one about 100 feet northwest, and one about 200 feet southeast, both of which can be economically reached by crosscutting from No. 2 shaft.

The buildings on the property consist of two hoist houses, two blacksmith shops, boarding and sleeping camps, old mill building and several other old log structures.

There was only a small force of seven altogether, of whom three were miners, working all summer. At the time of my last visit, Oct. 28, work was suspended altogether, and had been so since August.

MANHATTAN MINE.

The Manhattan mine consists of location K231, adjoining the Decca, and is distant about $1\frac{3}{4}$ miles north of Mine Centre on the Government road. It is owned by the Man-

hattan Gold Mining Company of Canada, Limited, with head office at Montreal. Frank Peterson of New York bought the property for the above company from Bush Winning, and Mr. Peterson is now manager. Operations were commenced in the latter part of 1898, and, with one or two intermissions, have been going on steadily since. A total force of seven is employed, not including the manager. There are four miners, working day and night shifts. The formation is protogine, and the vein is a quartz body of considerable width at the point where the shaft is sunk. The shaft had reached a depth of 170 feet on Oct. 28, the date of my last visit, and has a dip of 82° northwest. At a depth of 100 feet a crosscut has been driven northwest 40 feet, crossing the vein and passing through about 16 feet of quartz altogether. The shaft was supposed to have been sunk on the foot wall of the vein, but was in reality sunk in the wall, which consists of country rock mixed with quartz A considerable quantity of the quartz is white and glassy in appearance, but some very nice looking ore containing galena, zinc blende and other minerals is encountered in the shaft. Visible gold is found also. It is the intention of the company to sink to a depth of 200 feet, and then drift and crosscut. Probably another shaft will be sunk farther up the hill, at a more convenient location for regular mining operations, when the vein has been shown up well by the present workings. Machine drills operated by steam are employed, the exhaust steam being conducted by a 12 by 12 inch wooden pipe to the surface. The hoisting plant consists of a small duplex hoist, horizontal boiler, steel wire cable, steel bucket and pole skidway. The head frame is neat and secure. The dumping mechanism is economical and convenient. The bucket is provided with two horns six inches in length, one on each side near the bottom. Next to the chute the skids are spread, allowing the bucket to fall between so that the horns slide on the skids. When the required height is reached the engineer at the hoist by pulling a lever throws out a couple of pins, which catch the horns of the bucket as the latter is lowered, and the bucket thus turns over and dumps into the chute, underneath which is the tram car.

The ladderway at the time of my last visit consisted of ladders suspended for a distance of 50 or 60 feet, with no means of reaching a greater depth other than by the bucket. Ladders were, however, being constructed at the time for the completion of the ladderway. Instructions were left to construct the ladderway according to the Mines Act before Nov. 10, 1899. The mouth of the shaft, both hoisting compartment and ladderway, were neatly fenced, and the mine in other respects was in a suitable condition. Buildings consist of a shaft house, hoist house, blacksmith shop, office, manager's dwelling and boarding camps.

GOLDEN CRESCENT MINE.

Work has been resumed on the AD2 property, now called the Golden Crescent mine, since the spring of 1899, after having been suspended for more than a year. The property consists of locations AD2, 3 and 4, and is owned by the Golden Crescent Mining and Exploration Company of Ontario, Limited, with head quarters at Duluth, Minn.; capital $1,000,000 in one dollar shares. President, H. M. Bradely, Duluth ; vice-president, J. B, Kelil ; secretary, Geo. H. Claypool ; treasurer, Chas. F. Leland. The manager of the mine is W. G. La Rue ; foreman, Thos. Peller. Total force, 10 ; number of miners 6, working three eight-hour shifts.

Work has been principally confined to the shaft in the Gem tunnel, but a little has been done at a couple of other places since the new company has taken hold. The test pit on the Contact vein on AD4 has been sunk to a depth of 34⅔ feet. The Moose tunnel has been driven a few feet more, making its present length 153½ feet, but it has been discontinued again.

The main shaft, or the shaft in the Gem tunnel mentioned above, is 112 feet deep and is being continued. The cross section is 4½ by 9 feet wide, inside the timber. The tunnel is passed through at a depth of 28 feet. At a depth of 78 feet a pump chamber has been provided, with a No. 5 Cameron vertical pump. At a depth of 88 feet a drift has been run east along the vein 24 feet and one west 10 feet. The shaft is timbered from the surface to the roof of the tunnel, and cased in where it passes through the latter, leaving openings for passage from shaft to tunnel and guard rails across. A suitable ladderway has been constructed, but is not cased off below the tunnel. Instructions were left to have this done. The shaft mouth has been provided with a suitable guard railing.

Some large insecure masses of rock at the mouth of the tunnel had been propped up with light timbers; these were blasted down. The hoisting machinery consists of a small duplex hoist 400 feet of $\frac{1}{2}$ inch steel wire cable, 800 pound steel bucket, locomotive boiler $16\frac{1}{2}$ feet long by 42 inches diameter, pole skidway and head frame 16 feet high. The buildings on the property consist of engine and boiler house, blacksmith shop, office, boarding camps, etc.

FERGUSON MINE.

Mr. John Angove, a Cornish mining engineer, made an examination of the Ferguson mine for the present owners, viz, the Seine River (Ont.) Gold Mining Company, Limited, with head office, 1 Castle Court, London, E. C, England. Several weeks were spent by the engineer on the property, and all the shafts, five in number, were pumped out and sampled. The testing of the samples was all done by panning. If the report is satisfactory it is expected that the mine will be re-opened. All shafts and test pits have been fenced according to instructions.

OLIVE MINE.

A change has been made in the management of the Olive mine since last report. N. B. Hall, an energetic and capable mining engineer, has succeeded W. A. Preston, who held this position since the commencement of operations. Mr. Preston is still managing director of the company, but his duties in connection with the prospecting and developing of other properties owned by the Preston Gold Mining Company, the parent of the Olive Gold Company which owns this mine, preclude his holding a position which should occupy a man's time completely. The installation of additional milling machinery has led to variations in the number of men employed. There has been an average of about 50 throughout the year, including from 12 to 22 miners.

The main shaft is 251 feet deep. First level: West drift, 181 feet 10 inches; east drift, driven to connect with drift from B shaft, a total distance of 329 feet; drift east of B shaft, 199 feet, making a total length of drifting at the first level of 705 feet, including length of shafts; cross section of drifts from B shaft, 6 by 7 feet, other drifts, 4 by 6 feet, and 5 by 7 feet.

Second level: East drift, 186 feet; west drift, 88 feet.

Third level: Depth, 245 feet; east drift, 31 feet; west drift, 147 feet 4 inches; crosscut south from shaft, $76\frac{1}{2}$ feet with cross section $4\frac{1}{2}$ by $6\frac{1}{2}$ feet; crosscut, or chamber, north of shaft; length, 14 feet; width, 10 feet; height, 7 feet.

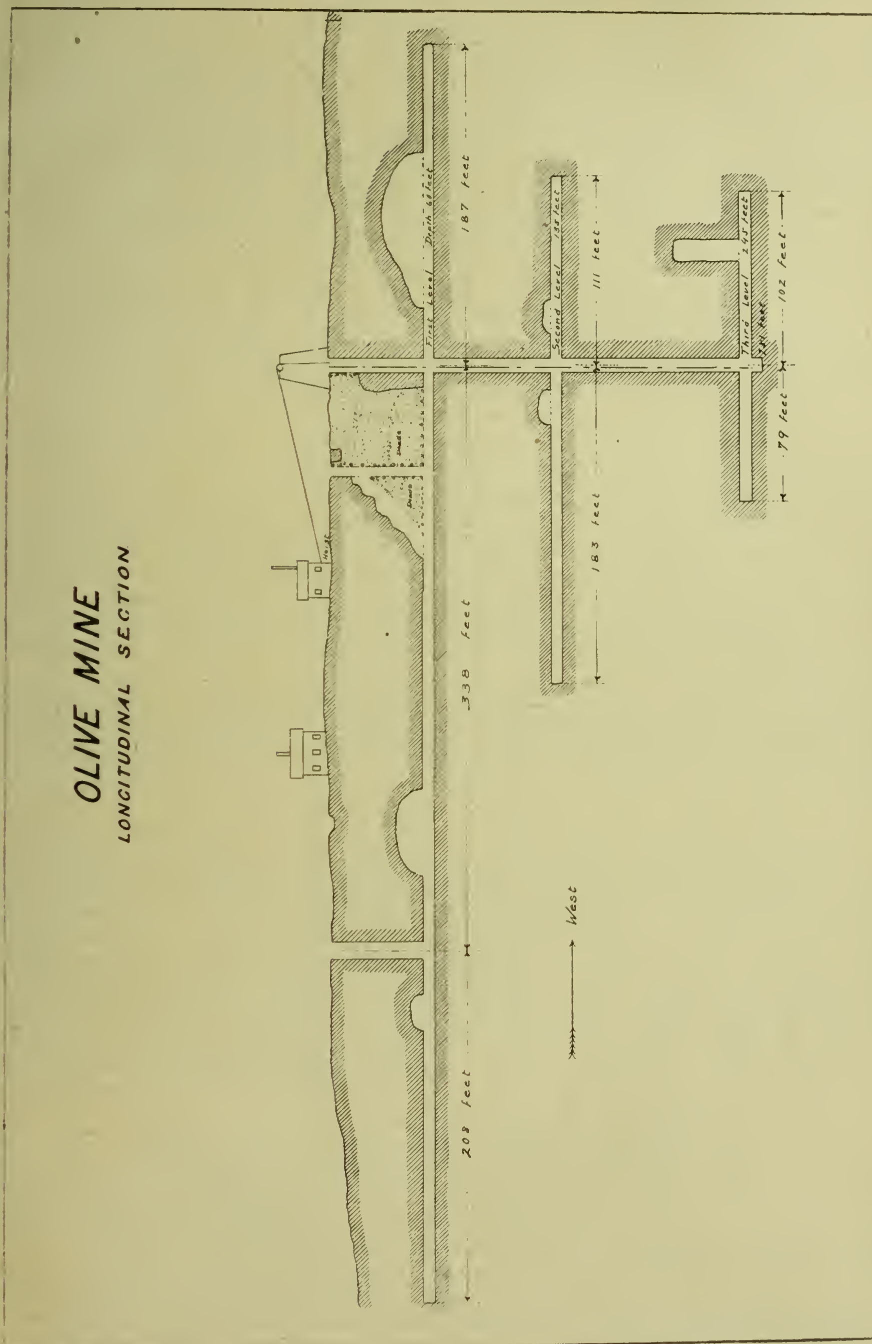
The following stoping has been done: First level, east of main shaft: All ore has been stoped out between the main and air shaft, a distance of 60 feet, leaving a small pillar at each, and the stoped out space has been filled to the surface with broken rock, supported on stulls along the roof of the drift. The stope has been carried east of the air shaft, but this work has been mentioned in last year's report. West of main shaft: Length of stope, 89 feet; height above drift, 18 feet; width, 3 to 4 feet. Third level, west of shaft: Length of stope, 13 feet; height above drift, 21 feet; width, $3\frac{1}{2}$ feet. No change has been made in the hoisting plant of the main shaft. B shaft has been provided with a steam hoisting plant, consisting of a small duplex hoist, $\frac{5}{8}$ inch steel wire cable, bucket, pole skidway and head frame 22 feet high. One of the old mill boilers has been placed alongside of the original hoist boiler to supply the additional power required. Two hundred feet of tramway have been constructed from B shaft to the main tramway, extending from the main shaft to the mill.

The main shaft is in a satisfactory condition. The ladderway has been suitably constructed to the third level. Instructions were left to provide a ladderway in B shaft according to the requirements of the Mines Act, and also a guard rail at the shaft mouth.

An addition of three batteries of five stamps each is being made to the present mill, giving a total of 25 stamps At the time of my last inspection, Oct. 28, the building addition was completed, the ore bins constructed and the mortars set in place. All the machinery was on the premises. A new 50 h p. boiler has been installed and connected with two others.

The increase in the milling capacity is not necessarily being made in accordance with the amount of developement work in the mine, but more as a result of a further know-

ledge of the ore body. The Olive ore body has been sufficiently described in former reports without going into detail here. It is well known as a small but persistent and rich



Scale : 110 feet = 1 inch.

quartz vein in a belt of schist several hundred feet in width. The schist varies in richness in different places; the best values are obtained next to the vein and where the schist contains small quartz stringers, which occur more or less reticulated. A certain

amount of the schist has always been milled along with the vein matter. The company intend with the increased milling capacity to mine and mill from 5 to 7 feet of the schist along with the vein matter. Owing to the great expense of getting in machinery further additions to the mill will not be made until the new railway, which will run within a few hundred yards of the mine, is constructed. The mill may then be increased to any extent from 100 stamps upwards, and the greater part if not all of the body of schist treated. The Preston company bought two diamond drills early in the season for exploratory work on their properties. One of these was employed at the bottom of the main shaft of the Olive mine, testing the body of schist. Bore holes made north and south showed a width of 430 feet of schist, or ore, which is of course low grade; but from what I could learn it can be profitably treated by a large mill. A new two-storey office, 24 by 30 feet in size, has been built, besides a private dwelling for the engineer, and one for the manager is to be built soon.

I received a letter from Mr. Hall under date of Jan. 19, 1900, as follows: "I beg to submit the following information relative to the Olive mine: Depth of A shaft, 245 feet; B shaft, 65 feet. Drifting done in A shaft: First level, west, 181 feet 10 inches; east, 127 feet. Second level: west, 106 feet; east, 178 feet 2 inches. Third level: west, 96 feet 11 inches; east, 74 feet. Drifting in B shaft: west, 202 feet; east, 199 feet. Length of drift connecting A and B shafts, 329 feet. Stoping: East drift, B shaft, 50 by 25 feet; west drift, 20 by 12 feet. In A shaft: First level, west drift, 35 by 36 feet: Second level, west drift, 4 by 20 feet; east drift, 20 by 6 feet: Third level, west, raise 45 feet. These measurements are up to Dec. 31.

"We started the 25 stamps on the 22nd of November, and have been running steadily since, with the exception of a few days when we were changing the crusher from the mill to the shaft, where we have an ore bin of 500 tons capacity, crusher and elevator, which works very nicely. Our new tram, 900 feet long, works like a charm. We have no trouble in hoisting, crushing and tramming 60 to 75 tons per day. We also have the new office, sleeping camp, assayer's house and shaft house completed, and considerable repairing done."

On G69, one of the Olive mine locations on the south, a 6 by 7 foot shaft has been sunk to a depth of 65 feet, with 27 feet of cross-cutting. The ore body consists of altered green schist, heavily charged with pyrites, and impregnated more or less with quartz.

SWEDE BOY MINE.

The Swede Boy mine consists of location E237, with an area of 43 acres, situated about four miles east of the Olive, or eight miles north of Mine Centre, on the south shore of Little Turtle lake. It can be reached from Mine Centre by land, but the easiest method is to take the road to the Golden Star, or the Olive landing on the south side of Bad Vermilion, cross Bad Vermilion to the Swede Boy landing on the north side of the lake, and walk a portage of a mile in length, which leads to the mine. The property is owned by the Headlight Gold Mining Company of Ontario, Limited; head office, Duluth, Minn., capital of company, $1000,000 in one dollar shares. President, J. P. Rossman, Duluth; vice-president, Geo. V. Burgess, Duluth; secretary-treasurer, A. E. McManus, Duluth. The manager of the mine is John McLeod. A force of 10 or 12, including from 4 to 8 miners, has been employed all summer. I visited the property on Aug. 11, and on Oct. 28.

The formation is a dark green schist with a strike of about east and west. There are two veins about 100 feet apart, and running parallel with the strike of the schists. The south vein is exposed in a test pit several hundred feet southeast of the main shaft. There is 8 or 10 feet of almost pure quartz, which possesses a schistose structure. This is the best showing of the vein, which is exposed very little. The north vein, on which the shaft is sunk, is exposed in several places by blasting and stripping. It reveals a width of 4 or 5 feet, and consists of quartz and schist mixed, and well mineralized. The schist between the veins, and probably even beyond them, contains mineralized and quartz impregnated zones, and possibly a considerable quantity of the rock will prove pay ore. Close to the shore of the lake, and at a convenient elevation for dumping, a shaft 6 by 7 feet in cross section has been sunk to a depth of 105 feet, and is being continued. It is vertical to the first level, a depth of 75 feet, and has a dip of 70° north below this. Another vein has been struck at the level, and is being followed. At the level a crosscut

has been driven south 75½ feet, and is being continued to cut the other vein. A crosscut has also been driven north 16½ feet and is discontinued. A drift has been driven east from the shaft 10½ feet and one west 6 feet. For hoisting, a small duplex hoist, ⅝ inch steel wire cable and 500 lb. steel bucket are employed. Steam is furnished by an 18 h.p. upright boiler. A pump is stationed above the level for drainage. A "Buffalo" blower, operated by belt from hoist, with six inch canvas tubing extending down shafts and into drifts, is employed for ventilation. It was observed to be the practice to have men lowered in the bucket to carry the end of the tubing into the crosscut to clear out the smoke and gases after blasting; and this being a dangerous practice it was recommended to employ iron piping instead of canvas, which could be extended permanently down the shaft and into drifts and crosscuts a sufficient distance to work effectually, without the necessity of men endangering themselves by going down in the smoke. A ladderway, provided with platforms at suitable intervals, has been constructed as far as the first level. Instructions were left to have it cased off from the hoisting compartment, and also to have the ladders extend from 3½ to 4 feet above the man-holes in the platforms. Instructions were also left to place a guard rail all around the shaft mouth and one around the hoisting compartment at the first level. The buildings on the property consist of hoist-house, office, manager's dwelling and boarding camps.

ALICE A. MINE.

The Alice A. mine has been in operation for the greater part of the year. In the fall of 1898 a Tremaine mill was installed for test purposes; the machinery consisting of one two-stamp Tremaine mill, Gates feeder, No. 7, Gates crusher, Frue vanner, with six foot plain belt, two small upright engines for crusher and for vanner, and two upright boilers. From 150 to 200 tons of ore, taken partly from the main shaft and partly from test pits at various places on the property, were treated The conclusion has been reached that a large percentage of the schist, which constitutes the principal portion of the formation on this property, can be profitably treated by a plant having a capacity of 200 or more tons per day. But by taking only the richest ore a much smaller plant would probably be profitable. Mr. Hillyer, the president of the company, has spent a considerable portion of his time in England endeavoring to arrange a sale of the property on such terms that a large mill will be erected and the present company retain an interest in the property. At the time of my last inspection, Aug. 9, the main shaft was 95 feet deep. At a depth of 60 feet a crosscut had been driven north 35 feet. This shaft is only for test purposes; sinking will be continued, with crosscutting in both directions across the ore body at certain intervals, until a satisfactory knowledge of the ore body has been obtained. The regular mining, when the large mill is installed, will be open work. A small duplex hoist has been installed, and also a four-drill Ingersoll straight line compressor, and machine drills. The boiler is locomotive style, and 35 h.p. The boiler and engine house is 26 by 30 feet in size, and neatly constructed. The company has put a saw mill with a capacity of 10,000 feet per day on the property. The manager of the mine is T. G. Prideaux. A total force of about 14 were employed. When visiting that section of the district in the latter part of October I learned from Mr. Prideaux that operations at the mine were suspended for a while.

GOLD BUG AND EMMA ABBOTT LOCATIONS.

An occasion was taken advantage of while at the Alice A. to walk over the Gold Bug and Emma Abbott locations, adjoining the Alice A. on the west and east respectively. The Gold Bug location is P660, containing 80 acres, and is owned by the Gold Bug Mining Company, Limited,; capital, $1,200,000. President, W. J. Keating, Fort Francis, Ont; vice-president, Hugh Steele; secretary and treasurer, Carroll Corson, Duluth. Offices, Mine Centre, Ont., and Keystone Block, West Superior, Wis. The Emma Abbott location is K215, consisting of 40 acres, and owned by the Emma Abbott Gold Mining Company with head office at West Superior, Wis.; capital, $1,000,000. President, Henry Clay Clark, Chicago; vice-president, Hugh Steele, Duluth; secretary, John S. Dodge, Minneapolis; treasurer, Lee J. Moss, West Superior.

The formation in each case is felsite schist, cut by large greenstone dikes, similar to the Alice A. Parts of the locations are swamp and bush covered, but a considerable

area is on high ground, which is largely almost bare rock, with a little moss, etc., and a light growth of timber. The schist is filled with small stringers of quartz from a fraction of an inch upwards, and in some places quartz veins 2 feet or more in width are exposed. In two or three of these veins there were large quantities of galena, copper and iron pyrites, etc. Test pits have been sunk on the quartz exposures in several places. On the whole the properties are very promising looking as prospects.

OTHER PROPERTIES.

The Rice and Thorbus property above Sturgeon Falls has not been in operation during the year, although Mr. Rice informed me last summer that he expected to have work resumed in the fall. It was examined by T. R. Deacon of Rat Portage for the company. Several other properties in the Lower Seine locality have been in operation more or less during the summer, but were not visited by me. At Calm lake, above Sturgeon Falls, some properties have been worked, but I did not visit this locality either.

UPPER SEINE REGION.

The condition of the mining industry in the Sawbill and Island Falls country is about the same. A number of new properties have been opened up and on some of the old ones work has been suspended. The prospector has extended his field of operations both northward and southward, and has been followed by the miner. Considering the inaccessibility of most of the properties in this locality, it would hardly be expected that mining would be carried on to the extent to which it is. The new railway will, however, help matters in this respect to a considerable extent.

DULUTH MINING CO. OF ONTARIO., LIMITED.

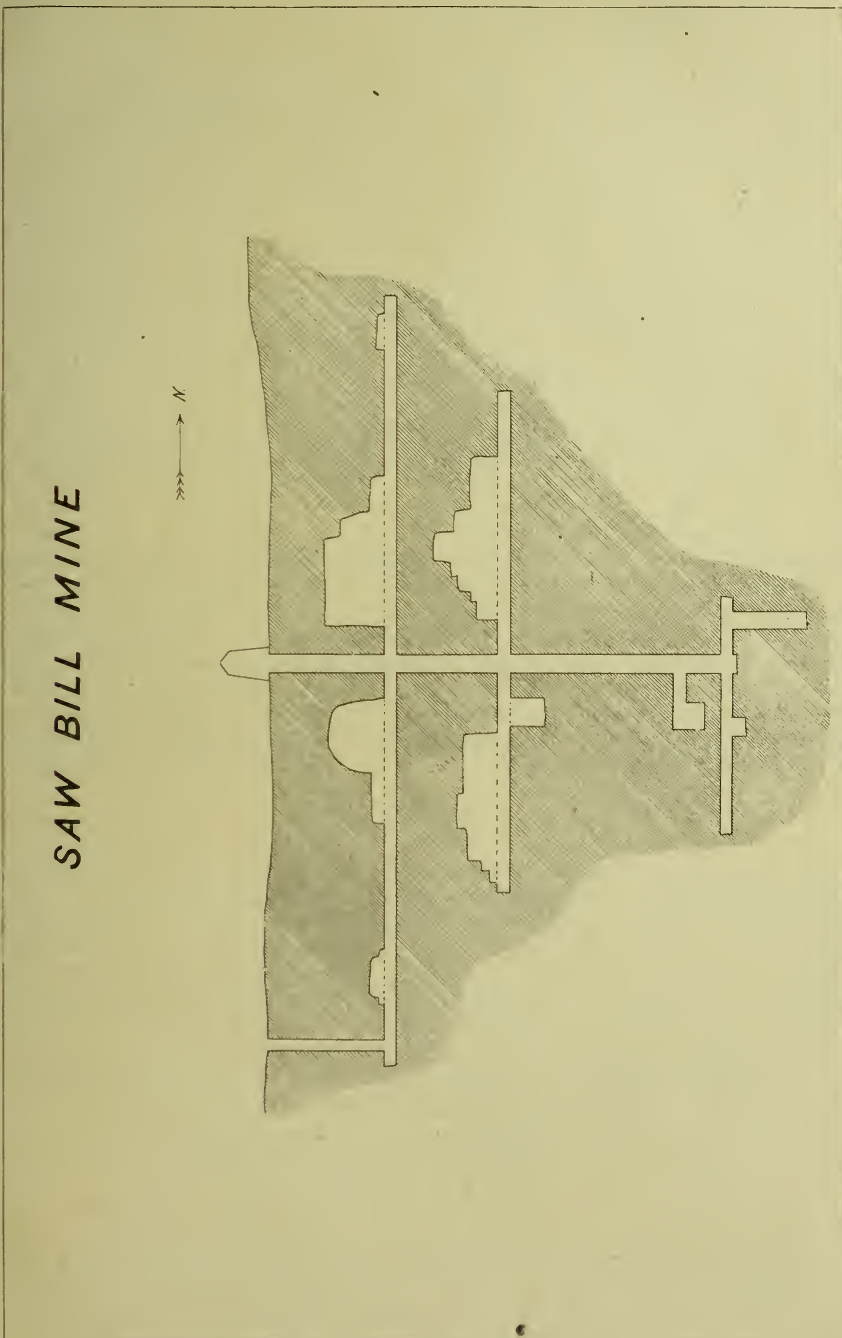
While on my way to the Sawbill I travelled on the stage with Messrs. Upham and Howenstein of the Duluth Mining Company of Ontario, Limited, who were operating on several locations a few miles north of Sawbill. I did not visit the properties, but got the following information from the above mentioned persons: On ES20 a shaft had been sunk 30 feet, and on AL303 a shaft had been sunk 46 feet on a large reef similar to the Hammond Reef. Ten men, including six miners, were employed all summer, and work will be continued all winter.

HAMMOND REEF MINE.

The property of the Hammond Reef consists of nine locations, and was originally divided between two companies, viz; the Hammond Gold Reef Mining Company, Limited, which owned two locations 337 and 338X, and the Folger-Hammond Gold Reef Mines Company, Limited, which owned the remaining seven locations, 316 to 322X. Both companies were composed largely of the same people. Developments showed that the installation of a large mill was necessary for the profitable treatment of the ore; and besides, there was a water power to be developed at considerable expense. Consequently, according to the dictates of mutual interest and advantage, the two companies amalgamated under the name of the Hammond Reef Consolidated Mining Company, Limited, with a capital of $5,000,000 in one dollar shares. I visited the mine on May 30 and found the machinery for 30 additional stamps on the premises, the foundations of the mill being prepared, and work on the water power in progress. No mining work was being done. On Oct. 2 I made my second and last visit and noted the following state of affairs: New work on 316X; about a quarter of an acre of the reef had been stripped and about 800 tons of ore from the large pit piled up on the surface, awaiting treatment. Instructions were given to keep the walls of the pit carefully scaled.

All the machinery was on the premises for the mill, crusher, aerial tramway and th electric power plant. The mill building was completed all but the roof, which was bein put on. The size of the building is 35 by 100 feet, and height 65 feet. The new mill i

an addition to the old 10 stamp mill; so that the total number of stamps is now 40. The new stamps were in place, and the mill was within a month of completion at the



time of my last visit. The crusher house was under construction. It is situated close to the pit, about 800 feet from the mill. The crusher is a Blake, with a capacity of 200 tons per 24 hours. A Bleichert aerial tramway will convey the ore from the crusher to

the mill. The discharge terminal is 70 feet above the loading terminal. Six buckets with a capacity of 600 lb. each will be employed. The cable for loading buckets is one inch in diameter, and for empties $\frac{7}{8}$ inch. The traction cable is $\frac{1}{2}$ inch. Only one standard will be provided between the terminals. The ore will be raised from the pit to the crusher by a power cable derrick. The water power is on the creek which runs from Clearwater lake into Sawbill, and is about two miles from the mill. Three dams have been constructed, including a small dam at Clearwater lake, 90 feet long, 10 feet wide and about 10 feet high at the centre. It is built of cribwork with broken stone filling, provided with a broken stone retaining wall and planked and sealed with earth in front. A gate is provided in the centre. Further down the creek there is a large dam to provide the head. It is about 150 feet long, 14 feet wide and about 18 feet high. The construction is similar to the preceding. The flume dam alongside is 65 feet long and constructed of framed timber with broken stone filling and earth seal, and flume gate in the centre. The flume is a round wooden tube constructed of two inch planks with iron hoops six feet apart. It is 700 feet long and five feet in diameter. Owing to natural obstacles it has a bend of 90° close to the dam, and another bend of a more obtuse angle about 400 feet further down. The head is 50 feet. Two turbines aggregating 325 h.p. have been installed. The generator, which furnishes 225 h.p., is not yet in place. The generator base is a solid piece of metal and weighs five tons. Its transportation from Bonheur to the head of Sawbill lake, a distance of 30 miles, was a serious problem owing to the very bad condition of the roads. A special waggon built to order with six inch tires was employed. The length of the transmission wire from the dam to the mill is 11,659 feet. Where it passes overland a clearing 40 feet wide is made along the route. The lake is crossed at the narrowest point, where there are several islands that are utilized. About 800 feet of water altogether is crossed. The wire is supported on poles for the entire distance. Three stone-filled cribs have been constructed to support the poles where the lake is crossed. There are two motors, one of 100 h.p. for the mill and one of 25 h.p. for the crusher. Neither were installed. About 200 yards of new road has been constructed in the vicinity of the mill, and about a mile of road connecting Sawbill and Clearwater lakes. A new pumping station has been provided at the lake. The pump is a Snow duplex. A conduit extends 275 feet out into the lake, owing to shallow water near the shore. Two lines of piping 2 and $2\frac{1}{2}$ inches in diameter extend to the mill. Wm. Tedford is manager of the mine. The total force is 40, of whom 8 are miners.

SAWBILL MINE.

I visited the Sawbill mine on two occasions during the year ; the first time on May 30, when I inspected the main shaft workings, and the second occasion on Oct. 2, when the shaft was full of water. The option under which the mine was being worked by a syndicate had expired just previous to the time of my second visit, and all the men were discharged. Captain J. P. Williams, the manager, the engineer and one or two others were still there. The mine will probably be closed down until the company is reorganized. Sinking, drifting and stoping had been carried on in the main shaft, and test-pitting on the surface ; and the mill was in operation intermittently making mill tests from various parts of the mine, underground and on the surface. On Sept. 20, 1898, while drilling at the bottom of the shaft, then 230 feet deep, water was struck which flowed out of the drill hole with great force, and continued so for months, flooding the lower part of the shaft and preventing sinking. Additional pumps were installed to keep the water down as much as possible. A drift was then driven along the vein at a depth of 220 feet, and a winze sunk at the end so that the water could be tapped and the pumps installed there so as to enable sinking to be continued in the shaft. The difficulty was finally overcome, and when the next or third level was established, at a depth of 243 feet, the ground was found to be quite loose and fissured. The captain informed me of the remarkable fact that a large fissure 6 or 8 inches in width extended horizontally along the level with a dip to the west when the level was first opened, but this fissure gradually closed as a result of the movement or settling of the country rock. When I examined it in May the seam corresponding to the closed fissure was plainly evident, and the ground was quite loose and broken up. I made a tracing of the longitudinal section of the underground workings at the time of my last visit, and got the following measurements from it :

Depth of shaft, 245 feet. First level, north drift, 190 feet; south drift 208 feet. Second level, north drift, 138 feet; south drift, 132 feet. Sub-level, depth, 220 feet; south drift, 30 feet; winze or cistern at end, depth, 9 feet. Third level, depth, 243 feet; north drift, 30 feet; south drift, 85 feet; cistern in south drift, 8 feet deep; winze in north drift, 14 feet from shaft, 50 feet deep; making total depth of lowest workings 293 feet.

Stoping: First level, north drift, first stope, length, 80 feet; average height above drift, 23 feet. Second stope, length, 20 feet; average height, 3 feet. South drift, first stope, length, 65 feet; average height, 20 feet. Second stope, length, 28 feet; height, 7 feet. Second level, north drift, length of stope, 87 feet; average height, 20 feet. South drift, length of stope, 80 feet; average height, 17 feet. The following test-pitting has been done on the vein, north and south of the shaft. At a distance of 800 feet north of the shaft an open crosscut has been made about 80 feet in length, from which 1000 tons has been blasted out. At one end of the open cut a pit has been sunk 20 feet, and at the other end a pit 14 feet. A sheared zone with a line of faulting extends along the open cut and through both pits. Stringers of quartz occur in the sheared zone. A mill run of 40 or 50 tons was made from this opening. At a distance of several hundred feet south of the main shaft the vein has been stripped for 70 or 80 feet. Several test-pits have been sunk on outcroppings of what appears to be an extension of the Hammond Reef, directly east of the southern limit of the Sawbill vein. One pit is 20 feet deep, another 8 feet and another 4 feet. No change has been made in the machinery about the mine or mill. Instructions were left in the Inspector's Book to fence all test-pits, and also to examine and scale certain specified places in the main shaft.

ROY MINE.

Work has been going on intermittently at the Roy mine during the year. On the occasion of my visit, Oct. 1, the total force was 12, of whom 4 were miners; but 8 miners had been employed all summer. The manager is Roy Sweeney, and the mine captain John Chapman.

The shaft is 105 feet deep, with a dip of 50° to 60° north. At a depth of 50 feet a drift has been driven west 10 feet. At a depth of 100 feet a drift has been driven west 71 feet. At the end a crosscut has been driven north 17½ feet, and one south 9 feet. At the same level a drift has been driven east from the shaft 55½ feet, and at the end a crosscut north 7 feet and south 21 feet. The size of all drifts and crosscuts is 4 by 6½ feet. The vein is quite strong in the shaft and drifts; at the end of the east drift there is 14 feet of quartz The shaft is timbered for a depth of 13 feet and provided with suitable platforms at the levels. A ladderway extends to the bottom of the shaft, but is not divided off from the skipway and is in poor condition. A Northey pump is stationed at a depth of 90 feet. Ventilation is secured by live steam, which is conducted into the workings by an iron pipe. The hoisting plant consists of a small single cylinder hoist with 12 inch drum, ⅝ inch steel wire cable, wooden bucket, four pole skidway and head frame 18 feet high, constructed of 6 by 6 inch timbers. A new 50 h.p. return tubular boiler has arrived and will be placed alongside the present one, which is of 10 h.p. A saw mill with a capacity of 12,000 feet per day has been put upon the property by the owners of the mine. The following instructions were left in the Inspector's Book: 1, Replace ladders above first level by others with more securely fastened rungs. 2, Case off ladderway from hoisting compartment, and provide landings at suitable distances apart. 3, Provide a suitable guard rail at shaft mouth and at man-hole on surface. 4, Keep walls of shaft carefully scaled. 5, Provide boiler with water tube.

PETTIGREW'S MINE.

W. D. Pettigrew of Winnipeg has been operating for the past two years in the Island Falls region. One of his properties consists of four 40 acre locations, viz., BG24, 25, 36 and 37, situated on King's lake about 14 miles up the Seine river measured along the winter road. The place can be reached by a slightly longer route by canoe, the last two miles being a foot trail. At the time of my visit, Sept. 30, the property was being worked under option by the Seine River Syndicate Mining Company, consisting of Scotch capitalists. The formation is altered granite. A ridge of the granite more altered than the formation in general, due doubtless to the fact of its having been a zone of

disturbance, extends through the property with a strike of northeast. The ridge zone or reef is about 100 feet in width, and has more or less well defined boundaries. A quartz vein several feet in width on surface but much larger underground occurs on the foot wall, and the hanging wall is marked by loose, faulted ground and stringers of quartz. The dip is about 45° northwest. The whole reef contains stringers of quartz to a greater or less degree in different parts. In general nature it is somewhat similar to the Hammond Reef. The quartz, where it occurs, is white, similar to that of the Sawbill, and contains coarse pyrite, copper sulphide and galena ; native copper is also found in it. On BG24 a shaft 5 by 10 feet in size has been sunk vertically to a depth of 108 feet. It was commenced in the hanging wall and the reef was struck at a depth of about 50 feet. At a depth of 100 feet a crosscut 5 by 7 feet in cross section has been driven southeast through the reef to the foot wall, a distance of 64 feet. On the foot wall side 25 feet of quartz is passed through. At the end of the crosscut 14 feet of drifting has been done in the quartz. The hoisting plant consists of a 16 h. p. duplex hoist, $\frac{5}{8}$ inch steel wire cable, 36 inch sheave, steel bucket and head frame 16 feet high, neatly framed of 8 by 8 inch square timbers. A tramway and car is provided down below, and the same on surface. Drainage is secured by a Worthington pump of 40 gallons per minute capacity. A No. 5 Cameron sinking pump is also on the property, but has not yet been installed and is used for pumping water from a well to the tank for the boiler. Ventilation is secured by a blower on surface operated by the crusher engine. Six inch canvas tubing extends down the shaft and into the workings. Suitable timbering has been provided for a depth of 15 feet from the surface ; and at a depth of 48 feet, where the shaft passes through the hanging wall of the reef, there is another 15 feet of timbering. A ladderway has been constructed with suitable platforms ; but is only divided off from the hoisting compartment for a portion of the distance, a guard rail having been provided at each platform instead. There is a trap door at the shaft mouth, but no guard railing. On the southeast side of the reef there is a test shaft which is said to be 26 feet deep, but is partially filled with water and not fenced. Blasting and test pitting have been done at other places also along the strike of the foot wall. A mill has been installed for test purposes, but so far has only been operated for a short time during the winter previous to my visit. The machinery consists of a Tremaine steam two-stamp mill, Gates feeder, Blake crusher, 25 h. p. crusher engine and 40 h. p. locomotive boiler.

The following buildings are on the property : Dining and sleeping camps, office, store house, stables, powder house, blacksmith shop, hoist and boiler house 18 by 20 feet, and mill building same size. The manager of the mine is W. D. Pettigrew ; superintendent, Jas. Huston ; total force, 16 ; number of miners, six. The following instructions were left in the Inspector's Book : 1, Case off manway from hoisting compartment. 2, Provide suitable guard rail at shaft mouth. 3, Fence 26 foot test pit south of shaft.

LOCATION AL282.

Operations had been resumed on AL282 a short time previous to my visit, Oct. 1, after having been suspended for the greater part of the year. The manager is James Hammond ; superintendent, Adolph Lequyer ; total force, 31 ; number of miners, 10. No sinking has been done since last report, but is just commenced. The shaft is 141 feet deep. At the first level, which is 96 feet from the surface, the northeast drift is 70 feet long, and the southwest drift 78 feet. The vein is a well defined quartz body in a band or dike of altered schistose greenstone about 6 feet in width. The country of this property, and in fact of all the Island Falls region, is altered granite. The greenstone dike material is quite soft, and well defined walls exist between it and the granite. The vein has also well defined walls, and ranges in width from 1 to 3 or 4 feet. A ladderway has been constructed to the bottom of the shaft, but is not cased off from the hoisting compartment ; nor is it provided in the vertical part of the shaft with suitable platforms. Instructions were given to remedy these defects, and also to construct a platform at the first level and to provide a guard rail at the shaft mouth. A new 50 h. p. return tubular boiler has been installed, and also a new Williams mine pump.

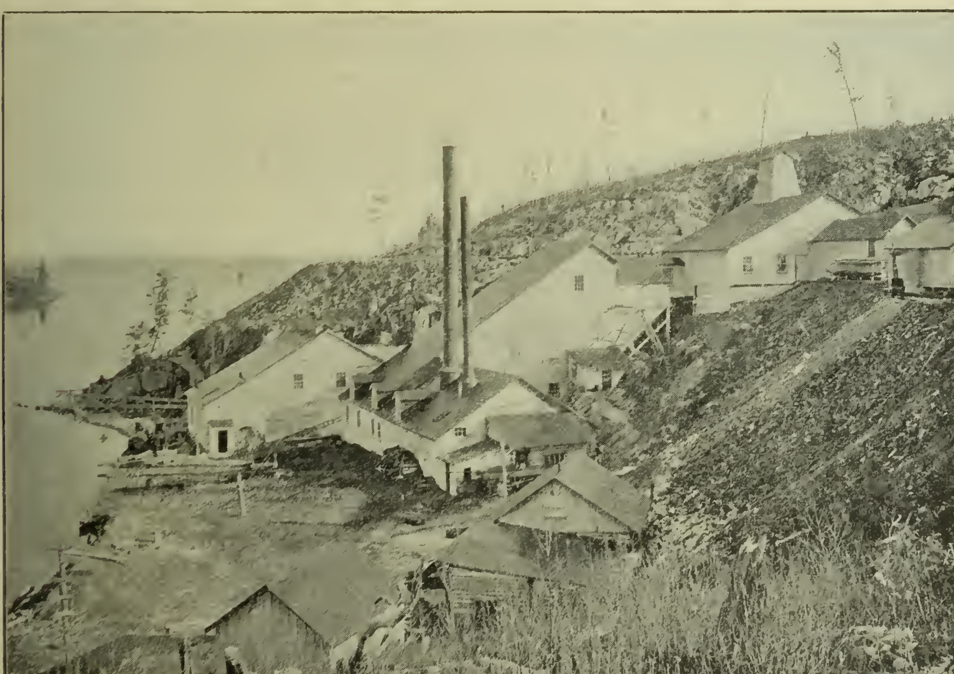
OTHER PROPERITIES IN THE ISLAND FALLS REGION.

Two or three other properties were being worked in the Island Falls vicinity, but not to any great extent ; and as they were out of the way, and it was getting late in the

22. Sultana and Burley Gold Mines, pp. 38, 42.

23. General View of Regina Gold Mine, p. 44.

24. Keewatin Reduction Works, p. 88.



25. Mill and Shaft House of Regina Gold Mine, p. 44.

26. Mill of Combined Gold Mine, Camp Bay, p. 50.

27. View of portion of Railroad from Mine to Mill at Camp Bay (Combined Gold Mining Co.), p. 50.

season, I did not visit them. However I got some notes from J. S. Steele on work done on properties up there which he was interested in and of which he was manager. The Clearwater Gold Mining Company, which owns the Big Six mine mentioned in last year's report, owns several locations in this region. Mr. Steele is manager of the company's properties and gave me the following information: On BG43 a shaft had been sunk 113 feet and discontinued. On BG45 a shaft had been sunk 55 feet and is being continued. A steam hoist has been installed. A number of test-pits have been sunk on the same property from 5 to 15 feet in depth. The ore body is a large quartz vein associated with a band or dike of green schist, and the formation is altered granite. With regard to the Big Six mine on Eye lake, south of Clearwater lake, I did not visit the place this year, as Mr. Steele, the manager, informed me that there was not sufficient going on to warrant the expenditure of time so late in the season. He gave me the following notes on recent progress on the property: Depth of main shaft, 100 feet; depth of first level, 80 feet; drifting north, 70 feet; south, 30 feet; crosscut, 10 feet south of shaft; direction, west; length, 18 feet. The steam hoist has been installed, and also a three drill air-compressor with three machine drills. Some test-pitting has also been done since last year's report. The saw mill is in operation and a planer installed. The Hammond Reef and other properties are supplied with lumber from this mill, as the company has a timber limit in connection with its mining property. New camps have been built on the property.

RUST AND WEADOCK PROPERTIES.

On Oct. 3 Mr. Steele took me down by canoe to location 325X, a 40-acre location owned by himself and two others, Mr. Ezra Rust and Geo. W. Weadock, both of Saginaw, Mich. The property is situated on Jack's lake, about 12 miles or three or hours travelling by canoe south of Sawbill. The route is by way of Moose lake and two other small lakes between it and Jack's lake, with short portages between. The formation is altered granite. A band or dike of greenstone extends through the same with a strike of northeast. Other dikes of the same rocks, also containing veins, occur close to the main dike. It is a general rule, as far as I have been able to observe, that all quartz veins in this altered granite formation are in or are associated with these greenstone dikes. It is well known that in the greenstone formation in other parts of the district the quartz veins as a rule are associated with felsite—generally occuring in dikes of felsite. This is more particularly true in the case of massive greenstone. In green schist many bedded or lenticular veins occur without the felsite. In the case of the altered granite we have the antithesis. In one case we have the quartz vein associated with or in fine grained siliceous dikes in a formation of basic rock or greenstone; and in the other, or the present case, quartz veins in or associated with fine grained basic or greenstone dikes in siliceous or granitic formation. The greenstone is usually schistose, especially next to the vein. Sometimes the whole dike is schistose, but it is the schistosity due to shearing and pressure, for wherever this feature occurs there is always distinct evidence of faulting, and the granite next to the schistose portion of the greenstone is more or less schistose, sometimes very markedly so. So that there is no doubt but all the bands of greenstone in this formation were originally massive, and of course of eruptive origin, and formed lines of weakness for the faulting, etc., of the country. These movements would, by shearing, grinding, etc., open up and otherwise render the zone of rock adjacent to the plane of faulting, or the dike, susceptible to vein-forming agencies.

The ore body or reef, loosely called a "vein" on this property, is an interesting deposit. At the north end of the outcrop an open cut 28 feet long, 5 feet wide and 5 feet deep, has been made across same. The reef here is about 20 feet in width. On one side there is a quartz vein with definite walls, from 6 to 24 inches in width, carrying large quantities of galena, zinc blende, pyrite, copper pyrites, and also visible gold. On the other side there is about 3½ feet of a poorer grade of quartz with indefinite walls. The material between consists of siliceous schistose matter, filled with small interlaminated plates or lenses of quartz and is the metamorphosed greenstone. A short distance south of the open cut a shaft 6 by 8 feet in size has been sunk to a depth of 45 feet on what is believed to be the wall of the reef, but as the granite next the reef is schistose and both the schistose granite and the greenstone are altered and impregnated with quartz, the walls of the reef or dike are rendered indefinite. The reef matter as seen in the shaft is mostly quartz,

which has displaced what was originally the greenstone. The schistose structure is as pronounced as ever, but what is left of the greenstone exists as mere leaves or plates of chloritic matter between the lenses of quartz. Visible gold is found in the shaft. The reef is mostly on elevated ground and well exposed. A few hundred feet south of the shaft it is cut by a narrow ravine which evidently represents a line of faulting. Between the shaft and the ravine the sheared or schistose character of the reef and granite adjoining is more pronounced than north of the shaft. South of the ravine the reef can be traced for a considerable distance, it is said for miles; but here the characteristics of the original dike do not seem to have been so much eliminated by shearing and alteration. Test-pitting and stripping have been done along the reef at intervals.

Another greenstone dike appears to branch off from the main one, and contains a quartz vein several feet in width but not traceable very far, nor very promising looking. There is a total force of 9 on the property, including 7 miners. Mr. Steele is manager of the work. The only building is a boarding camp. A temporary blacksmith's shop and a powder house have been erected, but others will be built soon.

The same parties own locations 682, 683, 684 and 685X, above Island Falls. I did not visit these properties, but was informed by Mr. Steele that a shaft had been sunk 52 feet on the line between 682 and 683X, with 24 feet of crosscutting at the bottom showing 24 feet of quartz.

LAKE SUPERIOR REGION.

Some exploration work was carried on in the Lake Superior region last year, but mining operations were not active.

EMPRESS MINE.

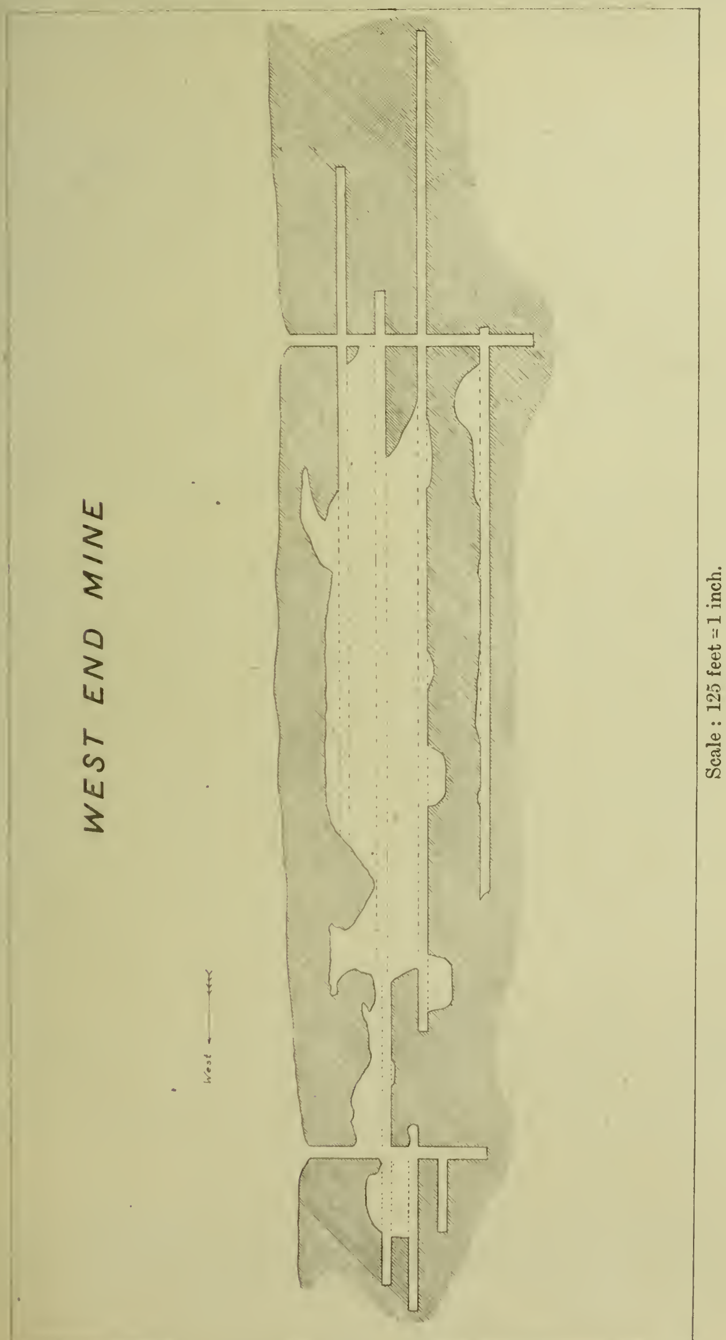
The Empress mine, which had been shut down for nearly two years, was re-opened in the spring of 1899 and work continued for the remainder of the year, when I was told it was again closed down. I visited the property on May 16 and Sept. 25. A report of the old workings is contained in the seventh report of the Bureau. Recent operations have been directed towards sinking a winze in No. 1 drift in the tunnel, and also doing a little further drifting and crosscutting in the tunnel level.

The winze is sunk from the end of No. 1 drift, which has been enlarged to provide a chamber for hoisting operations. The size of the winze is $5\frac{1}{2}$ by $7\frac{2}{3}$ feet, and the depth was 81 feet at the time of my last visit. It is sunk vertically into the ore body, which is over 100 feet wide. At a depth of 51 feet drifts 7 by 7 feet in cross section have been driven east and west 4 feet and $12\frac{1}{2}$ feet respectively. The ore body consists of pyritiferous hornblende schist containing stringers, bunches and veins of quartz. A vein of quartz 3 to $3\frac{1}{2}$ feet wide was passed through in the winze, where the drifting commenced. A considerable quantity of zinc blende was struck in the west drift; this is the first occurrence of this mineral so far known in the mine.

The second or No. 2 drift east in the tunnel has been driven to a total length of 103 feet, and a chamber at the end 8 feet high and 14 feet wide excavated for a diamond drill station. The third drift west has been driven a total distance of 108 feet. At a distance of 96 feet from the tunnel in this drift a crosscut has been driven north 22 feet and one south 42 feet. Machine drills operated by compressed air are employed. A small duplex hoist operated by compressed air is installed at the winze. Ventilation is secured by aspirator pipes, six inches in diameter, conducted from the workings to the mouth of the tunnel. Live steam is employed. No change has been made in the mill. It was being cleaned up for operation at the time of my last visit. A manager's dwelling and a new blacksmith shop have been built. The manager of the mine is Jas. O. Beebe; foreman, T. F. Waters; number of miners, four; total force, 14. The following instructions were left in the Inspector's Book: 1, Construct a ladderway in the winze according to the Mines Act, with division and platforms at suitable intervals. 2, Provide a trap door at least six inches thick at the level in the winze.

URSA MAJOR MINE.

I visited the Ursa Major mine on Sept. 25 and found that the shaft had been sunk to a depth of 117 feet, and neatly timbered for a depth of 80 feet. The hoisting plant



consists of a small duplex hoist, 32 h.p. locomotive boiler, wire cable and bucket. A pump station has been provided at a depth of 110 feet, but the pump was not instal-

led. An addition has been made to the shaft house for a hoist and boiler room. The superintendent of the mine was R. M. Chapman ; total force, 14 ; number of miners, 7. Instructions were given to construct the ladderway according to the Mines Act, and also to provide a guard rail at the shaft mouth. On Dec. 1 received a letter from Captain J. P. Williams, late manager of the Sawbill, who had just been appointed manager in place of Mr. Chapman. He stated that the instructions regarding the ladderway etc., had been carried out.

WEST END SILVER MINE.

Some of the old silver mines in the Lake Superior region have been worked during the year, but the most successful work has been carried on in only one of them, which is known as the West End mine. This mine has been in continuous operation, mining, milling and shipping during the year. I visited the property on May 10 and on Feb. 20 of the year following. At the time of my second visit I found that the mill had been shut down since the beginning of the preceding month on account of the lack of water supply owing to the cold weather ; but it will be started again when the thaw comes. The water is syphoned through a long pipe from a lake on the top of the mountain. At present only the rich ore is being shipped, while the mill rock is being piled in the stope underground until the mill is ready for operation again. The following are the underground measurements up to the date of my last visit: No. 1 shaft, depth, 150 feet, approximately (water in bottom). First level, depth, 53 feet ; west drift, 84 feet ; east drift, connected with No. 2 shaft. Second level, depth, 70 feet ; west drift, 102 feet ; east drift, 14 feet. Third level, depth, 88 feet ; west drift, 50 feet. Stoping : West of shaft, above second level, length, 52 feet ; height above floor of level, 35 feet. East of shaft, above first level, length, 90 feet ; height above floor of level, 13 to 25 feet.

No. 2 shaft, depth, about 155 feet (about 35 feet of sinking done since last report). First level—see last report. Second level ; west drift, connected with No. 1 shaft. Third level ; west drift, 444 feet. Fourth level ; depth, 132½ feet ; west drift, 355 feet ; east drift, 5 feet. Stoping : West of shaft, above third level, length, 410 feet ; average height above floor of level, 58 feet. Below third level (underhand), No. 1 stope, length, 38 feet ; depth, 35 feet. No. 2 stope, length, 40 feet ; depth, 13 feet. No. 3 stope, length, 25 feet ; depth, 5 feet. Above fourth level ; length, 85 feet ; height above floor, 11 to 23 feet. Stulls for supporting the broken are, with chutes at intervals of 12 feet, are under all stopes. At present, and until the mill starts, the ore from the lower levels is hoisted to the second, where a chute has been provided in the shaft to load the cars in the level. The ore is dumped into the stope below the second level and will be removed from the chutes in the third. Drainage is secured by four pumps in the mine ; a Cameron No. 7 and a Dean at the fourth level in No. 2 shaft ; and a Northey and a Cameron, each No. 7, at the second level in No. 1 shaft. A Copeland and Bacon duplex hoist with 8 by 12 inch cylinders and 36 inch drum has been installed at No. 1 shaft. The cable is ¾ inch in diameter, steel wire, and 400 feet long. A bucket is employed and a pole skidway constructed. The boiler is 35 h. p. locomotive style. A new tramway on trestle work about 350 feet long has been laid from No. 1 shaft to the mill. A new wood chute about 250 feet in length has been constructed south of the mill from the top of the mountain, but is not used at present as the wood supply is pretty well exhausted from that source and is being obtained now between the mine and the railway track. The force at present is somewhat reduced owing to the mill not being in operation ; the total is 30, of whom 16 are miners. No change has been made in the management.

PORCUPINE SILVER MINE.

The Porcupine mine is owned by the syndicate which is operating the West End mine. It consists of location 96T, containing 160 acres, and is situated 28 miles from Port Arthur on the colonization road, and two miles south of the P.A.D. and W. railway with which it is connected by a road. This is an old property which had been somewhat extensively worked, but had been idle for several years previous to the recent reopening. Accounts of it will be found in the early reports of the Bureau. There are several old tunnels and shafts on the property. Recent operations, which have extended over a period of about a year, have been confined to driving a prospecting tunnel into the

foot of the mountain to reach the junction of two veins. I visited the property on May 11, when the tunnel was in 96 feet. This part was all in loose earth and was timbered and lagged for the entire distance. The solid rock (slate) had just been reached. A force of three miners was employed, with Tom Davis as mine captain. While at the West End mine I learned that this tunnel had reached a length of 200 feet, where the vein was struck, and 50 feet of drifting done on the vein. There is 100 feet of stoping ground above the drift.

RABBIT MOUNTAIN SILVER MINE.

The Rabbit Mountain mine is situated about 25 miles southwest of Port Arthur. The road to the mine leaves Stanley on the P. A. D. and W. Ry. The property had been extensively worked years ago when in the possession of A. M. Hay of Rat Portage. The shaft was 240 feet deep and there were four levels with an aggregate of about 1,000 feet of drifting and crosscutting. The property was bought in Dec., 1898 by the Dominion Gold Mining and Reduction Company, Limited, of London, Eng., and work resumed. I visited the mine on May 8. The shaft was then 300 feet deep, with drifting in progress at the bottom or fifth level. The main vein has a strike of north 25° east, and is said to be traceable for a great distance. A large diabase dike meets the vein on the east, but does not cross it; evidently the vein is on the plane of faulting of the dike. The shaft is sunk on the vein where the dike meets it, and the best ore occurs in the dike, or close to it. The latter is found in the first four levels, but not yet in the fifth, and the drifting there is being done with a view to reaching it.

The Rabbit Mountain Junior vein is about 400 feet west of the main vein, and dips towards the latter at an angle of 45°. It is calculated that the veins would meet at a depth of 400 or 500 feet. It is the intention, some time in the future, to continue the main shaft to the junction with the hope of finding good ore. There is an old shaft which is said so be 90 feet deep on the Junior vein, but was full of water at the time of my visit. The main shaft is not in safe condition. There is a ladderway extending to the bottom, but it is not cased off from the hoisting compartment nor provided with platforms. The hoisting compartment is not fenced off at the various levels. Instructions were given to fulfil these requirements if the mine continued in operation. The hoisting machinery is in satisfactory condition. It consists of a 60 or 65 h. p. duplex double drum hoist, with grooved drums 48 inches in diameter, 1,000 feet of $\frac{7}{8}$ inch steel wire cable and steel bucket of 1,500 lb. capacity. There is a 10 drill Ingersoll compressor, four drills and a receiver 4 feet in diameter by 11 feet in length. The compressor was not in use at the time of my visit. The boiler is a return tubular of 100 h.p. capacity. There is an old mill on the property which has not been in operation since the mine was worked years ago, but it could be put into working condition without great expense. The machinery consists of a Blake crusher, Tulloch feeder, five stamp battery, two Frue vanners with four foot belts, settling pits and buddles. Tho mine was closed down a few days after my visit.

BLAKE AND BOSTON COPPER MINE.

On May 13 I drove out to a reputed native copper deposit in Blake township, about 30 miles south west of Port Arthur. It is known as the Blake and Boston copper mine, and was being operated by George T. Marks of Port Arthur. The only evidence of ore consisted of two outcroppings about 100 feet apart on the face of a hill. But a little blasting and excavating proved that they were only large "float" boulders, 10 or 12 feet in diameter, of amygdaloidal trap, portions of which were rich in native copper. From their angular appearance it must be inferred that their origin is not very far distant, but the country in this vicinity is so deeply covered with drift that it would be a difficult matter to find the ore in place. The formation as exposed on the face of the hill is coarse trap similar to that of the south shore of lake Superior. Richard Sandoe was manager of the mine, and four miners were employed.

PRITCHARD HARBOR COPPER MINE.

On March 22, 1900, Frank Hockley of Rat Portage gave me some notes on the Pritchard Harbor copper mine, in which he is interested. It is situated on the south

shore of Black bay, about 10 miles in a straight line from the railway, or 40 miles by boat from Port Arthur. The property consists of locations 201, 206, 207 and 208McA, aggregating 168 acres. It is owned by the Pritchard Harbor Copper Mining and Development Company, Limited; head office, Rat Portage. President, W. McLeod; vice-president, Dr. W. J. Chapman; secretary-treasurer, Frank Hockley; engineer, J. A. McAree. Work had been going on for about $4\frac{1}{2}$ months with a force of 6 miners, but was suspended about the middle of March until navigation opened as the expense of getting in supplies is too great in the winter time. The work done consists of two tunnels, 20 and 22 feet long, and a shaft 31 feet deep. The ore is amygdaloidal trap, containing native copper. I saw some specimens in Mr. Hockley's office which were said to have come from there. They showed a considerable percentage of native copper.

TIP-TOP COPPER MINE.

There is a copper deposit about 30 miles southwest of Savanne, which I have heard is likely to be of some importance. I have not yet visited the place, but on Feb. 20, 1900, I got some notes from F. A. Folger, who is interested in the property and was just on his way to it; it is called the Tip-Top mine. There are four locations, K61, 62, 63 and 64. It is owned by the Folger Bros. of Kingston, James Hammond and others. The ore is copper pyrites, and there is said to be a great quantity of it. Two shafts are being sunk about 700 feet apart on the vein. Work was going on at the time I met Mr. Folger.

ZENITH ZINC MINE.

There are indications of the development of a zinc mining industry on the north shore of lake Superior, in the vicinity of Rossport. One mine has been shipping during the last two winters, and test-pitting is being done on another property. I am told that prospecting operations are to be commenced on a third property immediately.

The Zenith mine consists of location 30T, which has an area of 160 acres, and is situated 13 miles north of the railway. The road to the mine leaves the railway five miles east of Rossport, at a point where a siding known as "Zinc Siding" has been constructed for the shipment of ore. Winston, a flag station $1\frac{1}{2}$ miles east of the siding, is the nearest point where the regular train stops. The road to the mine is only a winter road, as 12 small lakes are crossed. This is representative of the country in all directions in this vicinity. It is extremely rough, and the shores of the lakes are all steep. It would be practically impossible to construct a summer road for any such distance. There is a continual rise from the railroad to the mine, making a total of 1,200 feet I am told. There are some long and steep hills on the road, but the slope is downward towards the railway in all instances where the hills are of any consequence, so that no great difficulty is experienced in this respect in the haulage of ore. Shipping can of course only be done in the winter. In the summer the same route is passed over to reach the mine, but on account of the number of lakes to be crossed the trip is made by canoe. The portages are all well cut out, and the time required to make the trip in the summer is about six hours. The mine is owned by the Grand Calumet Mining Company, Limited, head office, 37 Trust Building, Ottawa. President, W. J. Poupore; vice-president, P. W. Resseman; secretary-treasurer, E. L. Leetham; managing director, H. J. Beemer. The post office address of the mine is Rossport, C.P R. The superintendent of the mine is J. E. Hoolihan; foreman, James Whalen; foreman of cobbing table, Frank McPhee. Total force, including teamsters, cobbers, etc., eighteen.

I visited the property on February 21st, 1900. The snow being deep, I could not examine the vein, and as no mining was going on at the time the shafts were full of snow. The formation is coarse trap. I was told that there are two veins, one of which can be traced for a long distance. Three shafts had been sunk; No. 1, on the junction of the veins, 35 feet deep; No. 2, 40 feet deep; and No. 3, 12 feet. There was also a small open cut from which about 100 tons of ore had been taken. This is all the mining work that has been done on the property,

It appears that although the vein is continuous on the surface, and presents a good showing at places, the ore does not extend to any depth, although the depth is variable at different points along the vein. The consequence of this is that the mining will con-

sist of making a series of open cuts or pits along the vein. I do not know to what extent this rule applies; it may be very local. The ore of the Zenith is pure zinc blende, dark in color. In the vein it is mixed with a certain proportion of country rock which is separated by cobbing. When I was at the mine the only work going on was cobbing and shipping of ore which had been mined during the previous summer and spring. The ore was conveyed to a roughly but substantially constructed platform, known as a "cobbing table." It is there broken by sledges into pieces the size of a hen's egg. A double purpose is served by this process; the barren rock is all removed, leaving pure zinc blende, and the ore is rendered more convenient for shipping. It is packed in canvas bags containing 125 pounds each. Five teams are employed in hauling the ore to the railroad, a distance of 13 miles. Each team makes one complete trip per day and takes from $2\frac{1}{2}$ to 3 tons per load. Thus the cost of transportation from the mine to the railway amounts to about two dollars per ton, which is not a serious matter for ore that is so valuable as this. It is not at all probable that the cost will ever be reduced unless it is found there are very great quantities of ore, as the cost of building any kind of a railroad through such a country would be prohibitory. This property was originally discovered and taken up by the McKellar Bros. of Fort William about 20 years ago, but was not worked with a view to shipping ore until the winter of 1898-99. It was then owned by H. J. Beemer, the managing director of the present company. Mining and shipping were carried on from Jan. 16 as long as the roads were good, and after that mining was continued for a few weeks. The present company bought the property from Mr. Beemer and is endeavoring to sell again, as it intends to work a zinc-lead property on Calumet island in the Ottawa river. If the company do not sell mining operations will be continued during the coming summer. The buildings at the mine consist of boarding camps for the accommodation of 40 men, office, stables and powder house, and stables and camp at the railway. Machinery consisting of boiler, hoist and two steam drills was brought in last winter but never installed. Instructions were given to fence all shafts.

GESIC ZINC MINE.

The Gesic mine is about two miles south of the Zenith, on the same road. There are ten locations, aggregating 400 acres. The owners are W. A. Johnson, C. Palmer and J. Hare of Toronto, who are forming a stock company to take the property over; F. W. Easton is manager of the mine. I visited the property on Feb. 22 while returning from the Zenith, and found operations in progress on location ES79. A test shaft with a dip of 50° or 60° north had been sunk 23 feet on the vein and was being continued. The formation is trap; the vein is said to be traceable over several locations, with a strike of east and west. At the surface of the pit there is very little mineralization; in fact the vein appears to consist of only a sheared zone of country rock. But at the bottom of the shaft zinc blende is making its appearance in promising quantities. A force of four miners was employed. Work had been going on since the latter part of Nov., 1899.

I understand that a discovery of zinc has been made at Mazokama on the C.P.R. west of Rossport, and that prospecting operations have commenced.

IRON ORE LOCATIONS.

Prospecting operations on iron locations are being conducted at several points east and west of Port Arthur, but I have not visited any of these places.

In September last a trip was made on the P. A. D. & W. railway to a location a few miles from Gunflint, where it was reported a very valuable iron deposit had been discovered, but on examination it proved to be too much mixed with greenstone to be of any value. Appearances however were encouraging, and possibly valuable deposits will be found in the vicinity.

Mr. A. M. Wiley of Port Arthur informed me that he and his brothers own 1400 acres of land containing valuable deposits of iron ore about 12 miles up the Pic river, near Peninsula harbor. The ore is said to outcrop on the banks of the river. It is free from titanium, and contains only a very small percentage of sulphur and phosphorus. Diamond drilling will be done on the property immediately.

A tunnel is being driven through a mountain of iron ore on the Atikokan, which is famous for its iron deposits. I have not yet visited the place.

It is reported that prospecting operations are to be commenced immediately on a property about 30 miles east of Port Arthur.

On the Mattawin river, west of Port Arthur, the Government diamond drill is at work on a number of large deposits.

It is altogether likely that prospecting for iron will be carried on vigorously during the coming summer.

REDUCTION WORKS.

Reduction works for the treatment of gold ores are in operation in the vicinity of Rat Portage, but are doing only a limited amount of work.

RAT PORTAGE REDUCTION WORKS.

The Rat Portage Reduction Works were held under option by A. B. Upton of Duluth for a short period, but have reverted to the owners. The works have been recently engaged in treating a lot of 215 tons of ore from the Wendigo mine, and are open for business.

NORMAN REDUCTION WORKS.

The Norman Reduction Works, which were being erected by the Canadian Gold Extraction Company, Limited, under the superintendence of R. H. Ahn, were never completed.

KEEWATIN REDUCTION WORKS.

The Keewatin Reduction Works have only been in operation about one-third of the time during the year, but the assay and testing departments have been kept fairly busy always. The summer is much the busier season. Most of the ore comes by water from the Lake of the Woods mines, but a reasonable proportion comes by rail. No change has been made in the plant. The jigs have been completed and work satisfactorily. There are two of these, with three compartments each. The first compartment has about $\frac{1}{8}$ inch stroke and the other two decrease in succession. Iron pyrites is used for bedding. Lately the operations of the works have been directed towards doing test work in cyaniding and concentration of ores. This work is done chiefly on ores from British Columbia and from the Sudbury region. The testing is for the purpose of ascertaining the proper kind of plant to install. A small jig, a plane table, etc., have been installed for concentration testing, and a series of small vats for cyaniding. Chlorination testing can also be done in the laboratory. During the summer a total force of eight is employed, including the manager, W. J. Craig, the assayer, H. A. Guess, and the mill superintendent. The last mentioned position is vacant at present.

MINES OF EASTERN ONTARIO

By Courtenay De Kalb, Inspector

The past year has witnessed a great increase of activity in the mineral industry of Ontario, and the prospects for the future are very encouraging. Doubtless some of the new operations will prove to be ephemeral, but in the main there is a substantial improvement in the situation. Some of the properties which appear to be in danger of suspension have been brought into their present state of embarrassment through incompetent management. It is most unfortunate that the difficult operations of development should so often be entrusted to men whose knowledge of mining is totally inadequate for undertaking such responsibilities. As I pointed out last year, there is a very general tendency to incur unwarrantable expenses in the equipment of mines in Ontario which are but little more than prospects. The progress of the industry in the Province would be enhanced by greater caution and economy in the initial stages in mining work.

The growth of the iron industry continues to be retarded by the efforts to produce ore to meet expenses before a sufficient amount of development has been done to render economical and steady operations possible. The same criticism will apply to most of the gold properties in the eastern district. The stone industry is apparently less flourishing than in former years, but is decidedly better than in 1898. Many new quarries are now being opened, and extensive operations are projected at the Forks of the Credit. There is also increased activity in the cement industry. New plants are being erected and old ones are being enlarged, while additional companies are being projected.

The mining methods pursued in the Provinse are very generally faulty, as was pointed out in my last report. A most efficient remedy would consist in establishing a system of licensing foremen, upon suitable demonstration of fitness. Not only would this soon result in more economical mining and in a general improvement of the condition of the mineral industry, but it would also lessen the number of accidents, which are becoming exceedingly frequent as a result of both ignorance and carelessness. The adoption of such a system would be in the interest not only of the owners of mining properties, but of the miners themselves.

GOLD MINES.

The greatest activity in gold mining in the eastern district of Ontario during the year 1899 was in the counties of Hastings and Frontenac, although prospecting has been carried on in many places in the western part of the district, and one mine (the Ophir), which had lain idle for a number of years, has been reopened and is now undergoing further development. Properly speaking, all the gold mines in the district are in a state of development, so that their operations are more or less tentative. A considerable number of the companies and syndicates interested have adopted the policy of erecting ten-stamp mills and milling the output of ore obtained in the process of development, so that they appear as producing mines. This policy has proven a wise one in a few instances, but in others it has been adopted, in imitation of the procedure of well-administered properties, when there was insufficient millable ore in sight to warrant the expenditure for such a plant. The tendency is very general to undertake production before enough development has been done to insure permanent operations, and the consequent irregularity of working seems to discourage capital and to raise a prejudice against gold mining in this district. It is to be hoped that in future more systematic and thorough development of the properties will be prosecuted before milling plants are erected, so that when production is begun it may be continued without interruption.

OPHIR MINE.

The Ophir mine was operated for a short period beginning in 1892. A twenty-stamp mill was erected and a pumping plant was established on the shore of lake Ickta, about 200 yards distant, for supplying water to the mill. The water-supply system has been

dismantled, but the mill has been preserved in good condition. It stands 411 ft. w. s. w. from the tunnel entrance to the mine, this being originally begun as a drift mine. The mill foundations measure 58 ft. by 81 ft., with a wing 37 ft. by 46 ft. for the power plant. The battery floor is 37 ft. by 58 ft., above which stands the rock breaker. The power plant consists of two 60 h.p. boilers and a 75 h.p. Reynolds-Corliss engine. A gravity tramway leads from the mine to the mill. The hoisting plant in use at the mine was a 16 h p. duplex hoist, taking steam from a 12 h.p. upright boiler. Diameter of drum, 18 in.; cable, $\frac{1}{2}$ in. in diameter. This stands 60 ft. s. w. of the shaft. The other surface accessories are a blacksmith shop, office, boarding and lodging houses, at varying distances south of the mine. The dynamite magazine was located 400 ft. from the mine and 150 ft. from the buildings. Instructions were given to remove this magazine to a distance not less than 600 ft. from the buildings, roads, or other places where workmen might habitually congregate or pass, which has been done according to advices received from the manager. The gravity tramway has also been repaired and made secure, in accordance with instructions.

The mine as it existed at the date of my visit (Sept. 2, 1899) consisted of a large irregular stope at a very flat angle (averaging about 45°), inadequately sustained by pillars left near the surface, and by stulls of such small diameter, and so poorly set, as to offer but little resistance. The hanging wall was exceedingly dangerous, and roof falls were common. The size of the stope was approximately 50 ft. x 150 ft., with a winze near the middle, and an incline at the s. w. end, now used as a sump and pump station. Sinking was in progress in the winze, which was being deepened from an original depth of 14 ft.

About 50 ft. s. e. from the mouth of this stope is an old shaft, 78 ft. deep, which was being timbered preparatory to sinking.

The plan proposed for safely working this mine, approved after a few modifications which are incorporated herewith, is as follows:—Sink the shaft to a depth of 100 ft., and drift on the vein from that point, under the old workings. Then to upraise into the old workings for air, but to make no other opening into the old stope. In order to prevent danger to the new workings below from the collapse of the roof in the open chamber or stope above, cribs are to be built about one-third of the distance from the bottom of the stope to sustain the hanging wall, which wall is then to be shot down, sorting out any ore therefrom and filling the waste into the lower part of the old stope between and below the cribs.

The owner of this property is Mr. Peter McArthur of Toronto. It is being operated on a working bond by a syndicate consisting of Messrs. E. L. Sawyer and E. Strachan Cox of Toronto, under the management of Mr. F. A. Fenton of Bruce Mines, with Mr. H. F. Downing as superintendent of mines. The number of workmen employed was 9 below ground and 6 on the surface. The location of the property is the south half of the north half, and the north half of the south half of lot 12, concession 3 of Galbraith, district of Algoma. The region is one of considerable geological disturbance, with many dikes of basic intrusives, apparently belonging to the same period of volcanic activity as that which resulted in the conditions leading to deposits of copper ores between this point and lake Huron at Bruce Mines. The Ophir deposit is associated with a dike of highly basic intrusive rock, with which, for a short distance at least, it is in direct contact. The ore deposit itself consists of quartz associated with chlorite schist, with diorite on the footwall. Further investigation of the geology of the deposit was impossible in the short time at my disposal.

DELORO MINES.

The Deloro mines, owned by the Canadian Gold Fields, Limited, have made notable progress within the past year, both in the establishment of a successful plant for gold extraction and arsenic recovery and in underground development. In detail, the extension of underground workings is as follows:—Gatling shaft deepened from 192 ft. to 341 ft., the depths to the levels being, from the surface to 1st level 70 ft., to 2nd level, 133 ft., to 3rd level, 233 ft., to 4th level, 333 ft. The Tuttle shaft has been deepened 5 ft. to 127 ft. A number of new shafts have been sunk for development of the deposit as follows:—Keswick D, situated 1250 ft. n. 8° 50′ e. from Gatling shaft, inclination 52° depth 50 ft. 6 in.; Keswick E, situated 1740 ft. s. 8° w. from Gatling shaft, vertical,

depth 29 ft. 6 in.; Keswick F, situated 1320 ft. s. 2° e. from Gatling shaft, inclination 10°, depth 50 ft.; Hawkeye No. 1, situated 1265 ft. n. 3° 30′ w. from Gatling shaft, inclination 32°, depth 165 ft.; Hawkeye No. 2, situated 1320 ft. n. 2° w. from Gatling shaft, inclination 55°. depth 42 ft. 6 in.; Gatling west crosscut—Vein shaft, situated 200 ft. n. 72° w. from Gatling shaft, inclination 60°, depth 53 ft.; Guyline shaft, situated 360 ft. s. 23° 30′ w. from Gatling shaft, inclination 82°, depth 47 ft. The changes in levels have been, in Gatling level No. 3 south, 257 ft. advance ; in Gatling level No. 4 south, 33 ft. 6 in. advance. Gatling crosscut west has been continued 106 ft., giving a total length of 356 ft.; Tuttle crosscut has been advanced from 40 ft. to 94 ft. Gatling west crosscut level has been carried north 88 ft. and south 112 ft. A raise is being driven in this level to connect with Gatling west crosscut Vein shaft. Additional work has been done in the air drift and in the Tuttle crosscut level. The size of the stopes at present is approximately as follows :—1st level, south of Tuttle shaft, length 80 ft., height 21 ft.; north from same shaft, length 80 ft., height 40 ft. A rib or pillar has been left in the north end of the stope 15 ft. above the level, 45 ft. by 30 ft. South of Gatling shaft, beginning beyond the shaft pillar (18 ft. from shaft), is a large stope 310 ft. long and varying from 10 to 50 ft. high, which is now more than a third full of stowage, sent down from the surface. North of Gatling shaft beyond the shaft pillar is another stope, 55 ft. long and from 10 to 25 ft. high. The 2nd level stopes are : South from Tuttle shaft, beginning 8 ft. from shaft, length 60 ft., height 48 ft., with a 10 ft. x 10 ft. pillar at mid-distance ; south from Gatling shaft, length 390 ft., height 63 ft., one-third filled with waste rock, and sustained by two waste pillars, one at the north end 60 ft. x 20 ft.,and another at mid-distance 20 ft. by 25 ft , and by 8 smaller pillars. The 3rd level stopes are · south from Gatling shaft, beginning 70 ft. from shaft, length 170 ft., height from 5 to 15 ft., working in 5 ft. cuts. The character of the walls is such that but little timbering is required. In the older upper portions of the mine, were the rock was weakened by atmospheric agencies, the stopes are being systematically filled with waste rock, and such timber as remains is being drawn and the walls secured by rock-filling. The shaft timbers and skipway in Gatling shaft have been carried down to the 3rd level.

The new mill, which was described in my last report, has been in operation since January, 1899. Meantime the old mill has undergone extensive repairs, and has been converted into a works for arsenic recovery only. The concentrates after treatment by bromo-cyaniding are dried, and then roasted in a revolving cylinder roaster. The fumes are condensed in a series of brick chambers with vertical baffle-walls. A new set of vertical galvanized-iron condensers of cylindrical form is being erected at the n. w. corner of the arsenic works. The fumes are collected from the condensing chambers and refined by re-roasting in a special form of reverberatory furnace, the fumes being condensed in a second set of brick chambers. Separate, securely sealed rooms are set apart respectively for bolting the arsenic and for packing. The arsenic is packed in kegs by the aid of an automatic jumper, and all kegs are plainly labelled and cleaned for shipment. A double wash-room is provided for the workmen, one part for clean clothes and the other for the clothing to be worn in the works. No arsenic fumes were observed in any part of the plant, and due precautions were observed to protect the employees. Antidotes are maintained constantly available in case of poisoning, and at least one man on each shift is fully instructed in their use. A physician is always at call by telephone. Owing to the tentative character of the operations at this mine in the past, no objections had been made to the present site of the explosives magazine, which is in dangerous proximity to the mine and surface plant. Instructions have now been given, however, to build a new magazine, of lighter construction than the old stone one, at a distance of at least 400 ft. from any works or roadway, properly guarded by a mound or other protective rise of ground, to be completed by June 1, 1900. Instructions were also given to provide hydrogen peroxide and hypodermic syringes for use in case of poisoning in the cyanide works. The manager of the mine is Mr. P. Kirkegaard.

THE ATLAS ARSENIC CO., LTD.

This company was incorporated in 1899, under the above title, with the following provisional directors : W. A. Hungerford, Deloro, Ont., H. J. Coe, C. S. Britton and J.

Prescott, of Cleveland, Ohio. The property consists of a tract known as "The Gatling Five Acres," surrounded on all sides by the lands of the Canadian Gold Fields, Ltd., about one mile from Marmora station on the Central Ontario Ry. The underground workings consist of two shafts. Shaft No. 1 is located 250 ft. s. s. w. of the mill, and has a depth of 85 ft. At a depth of 78 ft. the first level has been driven, extending n. e. 120 ft. and s. w. 100 ft. Stoping has been commenced in the northeast drift. Shaft No. 2 is 100 ft. s. e. of the mill and is 60 ft. deep. This at present is not working.

At shaft No. 1 a skeleton head frame 25 ft. high has been erected. Hoisting s done in a skip, using a $\frac{3}{4}$ in. cable, wound on an 18 in. drum on a portable hoist. The hoist and vertical boiler are all on one bed-frame, and are housed in a temporary shed adjacent to the head-frame. The mill contains ten stamps, one 7 x 10 in. Blake crusher, a Frue vanner, and a Wilfley table. This plant was installed by the Wm. Hamilton Mfg. Co. of Peterboro, Ont, A 3-rail inclined plane tramway brings the ore from the mine to the mill, a distance of 170 ft, with a total lift of 40 ft. The dynamite magazine is located 400 ft. e. s. e. from the mill behind a low eminence. Instructions were given as to proper cleanliness in the dynamite magazine, as to the proper use of the dynamite hot-water thawer, and as to proper protection by guard rail around shaft-mouth.

THE BELMONT MINE.

Since the last inspection this property has been purchased by the Cordova Exploration Company, Ltd., of Newcastle-upon-Tyne, England. The rights acquired are 300 acres in fee simple in Belmont township, Peterboro county; 125 acres of mineral rights only in Marmora township, Hastings county, contiguous; and 160 acres, including a valuable waterpower on Deer river, at the outlet of Deer lake, 2 miles n. w. of the mine. Since the acquisition of this property, after prolonged testing by the Cordova Exploration Co., extensive preparations have been made for permanent operations at this mine, and it is proposed to erect a large air compressor plant at the Deer river falls, where an effective head of 90 ft. is available, the air to be piped to the mine for use in all situations where power is required. A large electric plant is part of the projected improvement, and it is probable that current will be transmitted to Deloro for electric lighting at that plant.

In the scheme for underground work ten shafts are enumerated, of which No. 4 and 5 are closed, 8 and 9 are located but not sunk, and No. 1, 2, 3, 6, 7 and 10 are being operated. Shaft No. 1 has been deepened from 135 ft. to 250 ft., and is still sinking. The manager, Mr. D. G. Kerr, has adopted the plan, new in Ontario but common in the large mining centres of the West and South, of carrying the timbers and skipway close down to the bottom of the shaft, and using telescope rails for the remaining 6 to 10 ft., so as to hoist from the bottom while sinking, In blasting he uses the side cut, shooting to the foot wall, with 4 unkeying shots, with a line of least resistance of 3 ft. 3 in., and 3 sticks of 50 per cent. dynamite to each hole. Including key and following shots, 25 holes $1\frac{1}{4}$ in. diameter are employed for each 3 ft. 3 in. cut, the cross-section of the shaft being 16 ft. x 9 ft. The work is so skilfully done that no injury has ever been sustained by the timbers or skipway. The work of sinking has been greatly cheapened and facilitated since the introduction of this system. It is doubtful if a better example of scientific blasting has ever been seen in Ontario.

Shaft No. 2 has been deepened from 35 to 95 ft., and connected by levels with shaft No. 3. The latter has been carried down from 40 to 185 ft. Shaft No. 6 (new) has reached a depth of 85 ft. It is located 750 ft. n. e. from shaft No. 1, and has an inclination of 75° to the s. w. The cross-section is 12 ft. x 8 ft. It is single compartment with a manway. The hoisting works consist of a head-frame, 12 ft. x 14 ft. at base, and 20 ft. high to the sheave block.

Shaft No. 7 (new) is 425 feet north of shaft No. 1. It is vertical, 80 ft. deep, cross-section 16 ft. x 9 ft. The hoisting works consist of a closed head-frame 17 ft. x 35 ft. at base and 35 ft. high. It is provided with a 30 h.p. double drum hoisting engine, actuated by compressed air piped from the central air compressor plant.

Shaft No. 10 (new) is 560 ft. east of shaft No. 1. It is inclined 75° to the south, is 35 ft. deep, and has a cross section of 14 ft. x 10 ft. Hoisting is still being done by windlass.

The new levels are as follows: In shaft No. 1, at a depth of 200 ft., east drift 50 ft., west drift 50 ft. A pump station has been established near the shaft on this level, over a large sump 15 ft. deep, with a cross section of 15 ft. x 9 ft. The pump is a Northey duplex direct-acting, with a capacity of 250 gallons per minute. The motive power is compressed air at 85 lb. pressure. From shaft No. 2 the 50 ft. level extends 260 ft. n. w., and 110 ft. S. E. to shaft No. 3. The 90 ft. level extends 260 ft. n. w., and 110 ft. s. e. to shaft No. 3. From shaft No. 3, in addition to the 50 ft. and 90 ft. levels from shaft No. 2, is a level at 185 ft. extending 250 ft. n. w., with an upraise. started at a distance of 110 ft. from the shaft to connect with shaft No. 2 above. From shaft No. 7 at a depth of 75 feet., is a level drifting n. w. 20 ft. and s. e. 65 ft.

A new shaft house has been erected over shaft No. 3, having foundations 18 ft. x 35 ft., and a height of 30 ft. A 30 h. p. double drum hoisting engine is being installed, which will use compressed air as a motive power. The tramway from the mill to shaft No. 1 has been extended to No. 7 shaft, and will be continued around to shafts No. 6, 2, 3, 5 and 10 in the order named. The old mill adjacent to the No. 1 shaft house has been made over into a machine shop, and above this, on the same level as the shaft mouth, is a new blacksmith shop. The air compressor plant installed by the Rand Drill Co. is located 400 ft. e. n. e. from the mill, on lower ground than the other works, insuring perfect drainage of leading pipes. The building is of wood, 40 ft. x 60 ft., with boiler room attached. The compressor is of the latest model, cross compound, both steam and air. The indicators showed high pressure steam, 125 lb., low pressure steam, 25 lb., high pressure air 85 lb, and low pressure air 20 lb. Steam is derived from 2 return tubular, 70 nominal h.p. boilers, using water from the coolers and fitted with electric damper regulators.

The explosives mgazine is located 600 ft. south of shafts No. 2 and 3, and 450 ft. east of the air compressor plant. Protective mounds insure reasonable safety. It is well constructed of wood with steel shingled sides, the expediency of using which is, however, questionable. The practice of storing caps and fuse in the same building was objected to in this case as in all others.

The only addition to the milling plant consists of a Fraser and Chalmers ball pulverizing barrel for regrinding the stamp-mill tailings for re-amalgamation. A new carpenter shop has been erected 300 ft. s. e. of shaft No. 1, consisting of a 2 storey building, 24 ft. x 40 ft. on the foundations. A residence for the staff and a new office and warehouse have been erected also. Instructions were given to board off all manways from hoisting compartments in shafts, and to put up the signal code at all landing stations and in engine rooms.

BOERTH MINE.

This mine has come into prominence within the year as a producer of bullion, and development work is being actively prosecuted. Its prospects were for a time seriously crippled by an unfortunate experiment with a new process for the treatment of its ores, but a mill has now been erected which is claimed to be successful, and which proves that the ore presents no difficulties which are not well understood by technical men. The property is situated in Clarendon township (lot 28, 7th concession), in Frontenac county, about 12 miles west of Clarendon station on the Kingston and Pembroke Ry. The corporation is known as the Boerth Mining Company of Ontario, Ltd., with its head office in Windsor, Ont. The president is Henry J. Boerth, vice-pres. Abraham Marymount, and sec. and treas. Alex. J. Groesbeck, all of Detroit, Mich. The manager was C. C. Groesbeck (since superseded). The ore extracted has been chiefly by surface stripping and open cut work. One development shaft has been sunk to one side of the main lode, following an off-shoot of the vein. This is known as the Hattie B. shaft, and has an inclination of 65° to the s. w. Its depth was 120 ft., with a cross section of 8 ft. x 11 ft. At a depth of 75 ft. a level has been opened out, drifting south 28 ft. and north 25 ft. Hoisting is done with a barrel on a skidway. A ladderway is provided, without sollars, and not boarded off. The shaft house is 20 ft. square on the base and 32 ft. high. The hoisting engine house is 40 feet south of the shaft. A derrick hoist is used, with 6 in. x 8 in. cylinders, taking steam from a 15 h. p. marine boiler. The Uncle Sam shaft is located 160 ft. south of the Hattie B. shaft. This was full of water, but was said to be 35 ft. deep. Its cross section is 7 ft. x 14 ft. The mill is located 1700 ft. east of the

Hattie B. shaft. It was furnished by the Jenckes Machine Co. of Sherbrooke, Que., and contains one 7 in. x 10 in. Blake crusher, 10 stamps of 900 lb. each, with Challenge feeders, and 2 Wilfley tables. In an adjacent structure is the power plant, consisting of a 30 h. p. engine and a 35 h. p. boiler. Dynamite is stored in a magazine 800 ft. distant from the nearest buildings or workings. Thawing is done in a horizontal tubular thawer (Ontario Powder Co's model) in a separate building 100 ft. from the boiler house and 150 ft. from the mine mouth. Other buildings are an office, two lodging houses, blacksmith shop, and stable. Instructions were given as to complying with the regulations of the Ontario Mines Act concerning manway and protection of shaft mouth by guard railings.

COPPER AND NICKEL MINES.

The past year has shown but little increase in the exploration for copper, judging from the circumstance that almost no prospecting has been reported from regions where outcropping cupriferous veins are known to exist, as, for example, in the belt north of Thessalon and Bruce Mines where only one lode has been exploited, and in the eastern portion of the Province where a number of outcrops have locally attracted attention, but have not led to any development work save in the vicinity of Coe Hill. This is somewhat surprising in view of the prevailing high prices for copper. The inactivity in the east has been offset by a marked revival of prospect and development work in the Sudbury copper-nickel district. The amount of ore placed in sight by these works has, however, not yet attained any very considerable proportions. One property suffered collapse from a hasty and ill-considered experiment with a new process, and in two cases the Canadian Copper Company also committed the error of erecting expensive plant on new prospects which subsequently proved to offer no basis for permanent operations. The tendency in the copper-nickel district to undertake the installation of expensive plant in advance of a proper development of the mines is quite as noticeable as in the case of the gold mines of the Province.

BRUCE MINES.

At the time of my visit (Sept. 1, 1899) definite advices as to the expected change of ownership of this group of mines had not been received. The resident manager was Mr. George H. Trethewey. The mines described in my former report were still kept unwatered, and all instructions to insure safety had been scrupulously followed. The old Copper Bay mine, the scene of a serious disaster from a roof collapse many years ago, had been pumped out and was carefully inspected throughout. This mine, entered by the Bray shaft, is on a northwest extension of the Wellington vein, 350 ft. from the nearest shaft of the group previously described. This portion of the property, embracing 6400 acres, has been purchased by the Lake Huron Copper Syndicate, Ltd., of No. 31-33 Palmerston Buildings, Old Broad St., London, E. C., England. The shaft is 429 ft. deep, single compartment with manway, through which also pass the old Cornish pump rods and pump column, and the new pump column. The timbers, as might be expected in a mine containing copper pyrites, full of water, are well preserved. The ladderway is also sound.

There were 5 levels in the mine, drifting n.w. and s.e. from the shaft. Those to the n.w. led into a series of stopes, which were largely filled at the time of the collapse of the mine. The 1st level has been practically obliterated. The 2nd level, n.w. drift, is inaccessible on account of the debris. The s.e. drift leads into a series of old stopes, one running nearly east and west, the other, known as the "Fire Lode," running nearly n.n.w. The east and west cross-stope is continuous down to the 4th level, having only one floor-arch in place. Portions of the old level-floors on stulls still remain, and are in a dangerous condition. A drift continues westward beyond the stope a little above the 3rd level, and a winze at the east end leads down to a drift on the 5th level. There is also a connection between this stope and the Fire Lode stope. The 3rd level opens s.e. into the above-mentioned stope, and is filled with debris toward the n.w. in the caved portion of the mine. On this level is a pumping station, with a 9″x10″x5″

duplex direct-acting pump, made by Smith of Toronto. On the 4th level the n.w. drift and stope is more open to inspection, and on the 5th level it is possible to pass around the caved material for a distance of 243 feet. The depth to this level is 360 feet. The shaft below is full of water. A 10″x10″x5″ pump is stationed on this level. Toward the s.e. the drift is open 75 ft. to the old sump, which is directly under the winze from the 4th level. Beyond this point the drift is inaccessible. The walls throughout show no signs of weakness, nor any tendency to scale. The accident causing the loss of this mine was due to the falling in of the roof, or cap rock, between the 1st level stope and the surface. The thickness of this cap-rock averaged 30 ft., with a span of about 40 ft. across the stope. The slip occurred along a seam between the lode and the hanging wall. In various places throughout the Wellington lode true slickensiding is observable on the hanging wall, and this constituted a line of weakness. The grooving is nearly horizontal, indicating a shear fault, which has been occasioned by the intrusion of a dike of basic eruptive rock that has distorted the country rock over a large area, causing lateral movement along joint planes and opening up fissures on the joint planes crossing those along which movement occurred. The quartz vein-matter has been deposited along these opened joint planes, forming a complicated network of veins and veinlets. The structure of the rocks surrounding the more important veins or lodes has consequently been weakened originally, but the vein filling is for the most part so closely adherent to the enclosing rocks as to re-cement the walls, rendering them sound. This is particularly true as to the cross veinlets, but is not true of those walls which were slickensided. Hence the weight of the cap rock was sustained almost entirely by the grooving in the walls, and as this plane of division between the vein-capping and the hanging wall was inclined in the same direction as the open stope beneath it was only a question of time when it must have given away. The case is instructive as showing the importance of a careful inspection of fissure and joint planes in cap rock and floor-arches which in circumstances like this involve greater peril than stripping of the vein to the surface. The effect of the slip was to break through all floor-arches and stulls below to the 5th level, and only the narrowing of the stope between the 4th and 5th levels prevented the free fall of debris to the bottom. This accident, according to tradition, was unattended by loss of life, as the slip fortunately occurred between shifts, at a time when no employés happened to be in the mine.

ROCK LAKE MINE

The Rock Lake mine is situated about 12 miles north of Bruce Mines, the holdings of the company comprising the n. half of lot 2, concession 6 of Plummer, the n. half of lot 3, same concession, s. half each of lots 2 and 6, and all of lots 3, 4 and 5, concession 1 of Coffin, district of Algoma. The corporation has the title the Rock Lake Mining Co., Ltd., with the following officers: President, M. Wile, Buffalo, N.Y., secy., L. C. Holden, Sault Ste. Marie, Mich., treas., B. C. Coryell, Chesaning, Mich., gen. mgr., Arthur S. Burrows, Bruce Mines, Ont. The mine captain was Joseph Nullon and the number of workmen was 43 (Sept. 2, 1899). The ore consists of chalcopyrite, disseminated through a quartz gangue with hackly fracture, occurring in diorite, with a wall rock of altered diorite, having a resemblance to slaty structure. The trend of the lode is approximately w.n.w., bearing in the direction of a dike of dark eruptive rock apparently but little less acid than the diorite, through which it was intruded. The dike is from 150 to 200 ft. in width, and contains a very large proportion of diorite inclusions. The distance from the mines to the dike is about 1,200 ft. There is doubtless some genetic relation between this dike and the copper-bearing lode, which, however, time did not permit of my working out. There appeared to be a very close resemblance between the geological setting of this deposit and of those occurring at Bruce Mines. The underground workings consist of the following: A shaft 500 feet s.w. of the public road on lot 2, concession 1 of Coffin. The shaft is vertical, 9 ft. x 16 ft. in cross section, with 2 compartments 5 ft. x 7 ft. in the clear, and a manway 4 ft. x 7 ft. in the clear. Depth of shaft 168 ft. At a depth of 103 ft. a crosscut of 6 ft. has been driven to the vein, on which drifting has been done 48 ft. southeast and 49 ft. northwest. A tunnel has been driven on the other side of the ridge, 80 rods s.e. from the shaft, on lot 2, concession 6 of Plummer. The tunnel is 7 ft. x 7 ft. in cross section and 170 ft. long. In addition

there are numerous trenches and open cuts on other parts of the lode. The surface plant consists of a shaft house 18 ft. x 20 ft. base and 25 ft. high. Hoisting is done with kibble, to which on my recommendation a cross-head was added. A trestle extends 200 ft. from the shaft house to the dump. The power house is located 150 ft. n.e. from the shaft. The structure is 40 ft. x 50 ft on the foundations and contains 2 rooms, one for boilers, with 2 return tubular 80 h.p. boilers, the other containing a duplex hoisting engine with 24-in. drum, winding a $\frac{3}{4}$-in. cable and a 10-drill duplex Rand air compressor. Other buildings are a boarding house, lodging house and stable. The main dynamite magazine is a wooden building at the mouth of the tunnel, this tunnel being now abandoned. A small shed 400 ft. s.w. of the shaft is used for the day's supply of dynamite. Instructions were given to post up the signal code and to prohibit men from being raised or lowered in the kibble.

The Grand Portage mine, north of Thessalon, was closed down and hence was not visited.

COPPER CLIFF MINE.

This and the following seven mines are properties of the Canadian Copper Company. The new work done at the Copper Cliff since last inspection is as follows: The shaft has been sunk to the 12th level and 35 ft. below. Distance from 11th to 12th level 68 ft. on the incline of the shaft. Present depth of shaft, 886 ft., 10 in., being an increase of 76 ft. A drift has been started in a westerly direction from the shaft, which will meet the winze formerly sunk from the 11th level. The drift is now 39 ft. long. On the 11th level the n.w. drift has been extended from 42 to 70 ft., and the s.e. drift has been lengthened from 100 to 111 ft. Ten feet from the old stope on the n.w. drift, is a new stope 23 ft. high, 50 ft. long and 15 ft. wide. Sixty-five feet from the old stope on the s.e. drift is another new stope, 56 ft. high, 46 ft. long and 27 ft. wide.

On the 10th level, s.e. drift, is a new stope 51 ft. long, widening from 13 ft. to 14 ft., with a height of 34 ft. No further changes have been made in the mine since last inspection. Instructions given were to bar off the 8th level crosscut; prohibit the use of abandoned workings for the personal convenience of the men, providing suitable sanitary arrangements near enough to their place of work to be available; block up the timber under the 8th level sollar more securely, and post up signal code below ground.

EVANS MINE.

This mine has been stripped down to the 5th level, with the exception of a small rib of ore constituting part of the old pillar between the 4th and 5th levels, which it was expected would be removed within the next 8 weeks, (after Sept. 6, 1899). In all other respects the mine and plant remain unchanged. No guides had been provided for the cross-head down to the bottom as required by a previous order. In view of the small amount of work remaining to be done before the abandonment of this mine, and because the danger of accident from oscillations of the kibble has been lessened by the removal of the old floor-arches, permission was granted to continue hoisting by the present method until the aforesaid rib shall have been removed. But further hoisting by this method without installing such guides was forbidden, in case additional exploratory work might be undertaken at this mine. It was also required that in the event of further work being done here after the removal of the aforesaid rib the ladderway shall be altered so that no ladder shall be more than 34 ft. long, with suitable landings at the foot of each ladder.

MC ARTHUR NO. 1 MINE.

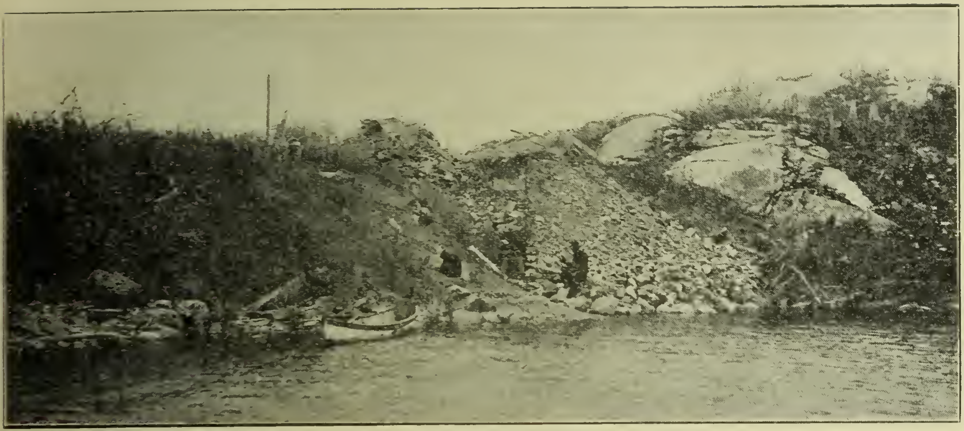
The original McArthur No. 1 shaft has been abandoned, but the new workings adjacent, known as Southeast extension, have been advanced. An open pit, with its major axis parallel with the strike of the lode, has been sunk 127 ft. deep, 75 ft. long, and varying from 8 to 30 ft. wide. The west or hanging wall needs frequent and careful "scaling." An open cut of irregular shape and 20 ft. deep has been driven about 100 ft. south of the open pit. Hoisting from the first pit is done by derrick and kibble, dumping into small pockets by the side of the tramway track. A small dynamite magazine is located 100 ft. west of the tramway, just s.e. of the old McArthur No. 1 shaft.

28. The Olive Gold Mine, p. 72.

29. Mill, Main Shaft, etc., of Olive Gold Mine, looking West, p. 72.

30. Shaft and Power House of Rock Lake Copper Mine, p. 95.

31. Road to Rock Lake Copper Mine, p. 95.



32. Quarry Island Gold Mine, near Sultana Mine.

33. Quarry Island Gold Mine, showing width of vein.

It was required that this be removed to a distance of 300 ft. from the track, unless the maximum quantity ever stored there at one time should not exceed 50 lb. of dynamite. The dry-house n.w. of the old McArthur No. 1 shaft has been completed and put in use.

MC ARTHUR NO. 2 MINE.

A two-compartment incline skipway has been carried down to what is called 2nd level, 100 ft. from the surface. This incline is to be abandoned and a shaft will be sunk behind it in the footwall. The angle of the present incline is 60°. The mine consists almost wholly of an open pit of very irregular shape, with two main openings separated by a rib, part of which constitutes a pillar supporting the roof of the remnant of a stope. The larger open pit measures 200 ft. x 100 ft., and the smaller 39 ft. x 35 ft. The pillar is 29 ft. x 20 ft. There is also a smaller pillar 9 ft. in diameter supporting the roof of the stope. Beside the larger pillar is temporarily installed a duplex direct-acting pump. All requirements as to indicator in engine room, fencing around open pits and location of magazine have been complied with. Owing to the slight incline of the skipway between the mine mouth and the "rock house," causing insufficient tension on the hoisting cable, it was required that safety catches be provided at once to prevent the skip escaping in case of breakage of cable, and it was also required to provide a detaching hook to prevent over-winding.

CLARA BELL MINES.

Mine A is distant about 3 miles n.w. from the Copper Cliff mine. The standard guage railroad has been extended from McArthur shaft No. 2 to these mines. The mine A consists of an open cut 40 ft. wide with a face 25 ft. high. Some work has also been done in an open cut above the lower one, but is not now being continued. Drilling is done by steam drills, deriving power from a small upright boiler temporarily set up near by. A power plant and hoisting works are being erected east of the mine, consisting of an engine room 28 ft. x 36 ft., a boiler room 22 ft. x 50 ft., containing two 100 h.p. boilers, and an air compressor room in which the compressor has not yet been installed. A rock house of the type commonly in use at the mines of this company was to be erected.

Mine B consisted of an open cut 40 ft. wide with a 20 ft. face, 1,200 ft. n.w. of mine A. The railroad extends to this point. A boarding house has been provided a little further toward the w.n.w. on the shore of Clara Bell lake.

THE MACDONALD MINE.

This mine is situated by the side of the railroad, 800 ft. s.e. of Clara Bell A mine. It consists of an open cut 50 ft. wide, with a face 16 ft. high. A power plant is being erected, consisting of an engine room 26 ft. x 30 ft., and a boiler room 22 ft. x 40 ft. The engine room contains a hoisting engine, duplex, 8 in. x 12 in. cylinders, and a 36 in. drum ; one 35 h.p. engine for rock house, and an air compressor, duplex, with 16 in. stroke, steam cylinders 10 and 16 in., and air cylinders 14 and 19 in., respectively. The boiler room contains one tubular boiler 60 in. x 14 ft., 70 h.p., and one of 54 in. x 12 ft., 50 h.p. The rock house will be 26 ft. x 41 ft. on the foundations and 35 ft. 8 in. high, to contain one 10 in. x 15 in. Blake crusher, and a screening and picking table plant. The magazine is located 500 ft. n.w. from the mine, with a rise of ground between it and the workings.

STOBIE MINE.

The changes in this mine since last inspection are those resulting from extension of the so-called stopes, which are really chambers, resulting from the extraction of wide ore masses. These are as follows : 2nd level stope, length 124 ft. (an increase of 40 ft.), width 45 ft., height 75 ft. (an increase of 15 ft.). 3rd level stope, length 108 ft. (an increase of 30 ft.), width 80 ft., height 70 ft. 4th level stope, length 100 ft. (an increase of 49 ft.), width 43 ft., height 75 ft. (an increase of 15 ft.). So far as could be seen the walls were not unsafe, but inspection of their condition in stoping chambers of such size was not easy. The requirements made for safety to miners have been attended to properly, and the mine is kept in good condition, well ventilated and drained. The main

explosives magazine is well located 600 ft. from the workings and buildings, but the small magazine was so placed as to endanger the rock house and the upper stope of the mine in case of explosion. It was ordered to be removed 300 ft. beyond a small rise of ground. The system of ore winning in use here not being in steps or benches, but by irregular cutting back of a face of irregular shape and considerable height, leaves no convenient means for access to the upper part of the workings, so that men handling drills and carrying tools to and fro are in more or less danger of accident. It was accordingly ordered that in such situations ropes should be provided to assist workmen in ascending and descending.

SIX AND SIX MINE.

Stripping of deposits, preparatory to mining, has been commenced w.n.w. from the Stobie mine, at a distance therefrom of nearly 2 miles. Two pits have been begun and at the most westerly point a small trestle has been built 40 ft. long to a dump. A railroad is projected from the Stobie mine to these new workings.

SMELTER PLANTS OF THE COPPER COMPANY.

The additions to the old smelter plant consist of two double coke sheds on the east side of the works. Each shed is 196 ft. long by 40 ft. wide; built in pairs back to back, with a trestle for a standard guage railroad between each pair. The structures are wholly of wood. A 40 ft. x 30 ft. boiler room for two boilers is being erected west of the assay office. A melting furnace for an iron foundry has been temporarily installed in the melting room of the bessemerizing plant. A new smelter is being erected about 300 feet s.e. from McArthur No. 2 rock house, on the brow of the hill, with ample dumping grounds for slag in the valley or draw in front. The dimensions of the new smelter building are 65 ft. by 127 ft. with room for 4 blast furnaces. The coke sheds are built into this building on the north side. The blower house is to be a detached structure, east of the furnace house, 30 ft. x 50 ft. with room for two No. 7 Connersville blowers, each blower driven by a 40 h.p. horizontal engine. The boiler house for the new smelter will be 30 ft. x 49 ft., for two 90 h.p. boilers.

A new water supply has been provided for the smelters by increasing the height of water in Clara Bell lake by means of a 6 ft. dam. The original area of the lake has thus been increased from 50 to 78 acres, and provision has been made for draining the level down 6 ft. through a canal 800 ft. long. This will discharge the impounded waters into Macdonald lake, the present source of supply.

New roast yards have been started with 8 roast-heaps along the n.w. side of the railroad track from the Copper Cliff to the McArthur No. 1 mine, at a distance of about 800 ft. from the Copper Cliff rock house. The same precautions are taken here against accident as at the old roast yards.

THE GREAT LAKES COPPER CO

This company has been organized with its head office at 60 State St., Boston, Mass., and the following persons as officers: John McKinley, President and gen. mgr., Horace Williston, sec'y., and C. M. Boss, supt. The properties are located on lots 5 and 6, concession 2 of Blezard, district of Nipissing, and lots 9 and 10, concessions 3 and 4 of Trill, district of Algoma. The company also owns 2,300 acres in the township of Davis, district of Nipissing. The mines lie near the middle of lot 5, con. 2 of Blezard, ¼ mile s.w. of the company's smelting plant. The workings consist of an open cut 10 ft. deep and 60 ft. long, of irregular width, averaging about 10 ft. Fifteen feet s.s.w. of this is a shaft 53 ft. deep, 7 ft. x 8 ft. cross section, cribbed 12 ft. to solid rock. Thirty feet from the top the shaft changes from the vertical to an inclined position. At the bottom is a drift north 10 ft. Hoisting has been done by windlass. Trenching and some open cut work has been done for a distance of a few hundred feet toward the s.s.w., and at intervals between the shaft and the smelter trenching and stripping have revealed other outcrops of ore. A diamond drill hole has been bored near the shaft to a depth of 125 ft.

The smelting works were built from original designs by Anton Graf of Vienna. The furnace house is 40 ft. x 36 ft., and contains two batteries of five furnaces each, the capacity of each furnace being 1,500 lb. of ore. The operation was to be discontinuous, each charge being separately smelted. The furnaces were to be fired by gas, using a small quantity of charcoal in the charge. It was expected to be able to produce high grade matte at one operation from un-roasted ores. The gas was derived from a small plant in a 12 ft. x 12 ft. building situated a few feet to one side of the furnace house, the gas being produced from some of the more volatile distillates from crude petroleum. This part of the process, however, was secret. The gasometer in the gas house had a capacity of 120 cu. ft. The power plant was in a room adjacent to the furnace room, and contained one 50 h.p. upright boiler, one 25 h.p. and one 30 h.p. engine, one Knowles' steam pump, 8 in. x 9 in. x 6 in., one Davidson's air pump, 6 in. x 8 in. x 12 in., and two Sturtevant exhausters and blowers, 14 in. in diameter. From these last were tunnels leading to the furnaces. Thirty feet east of the engine room was a tank house, 26 ft. x 28 ft. Other buildings are a rock house 300 ft. s.w. from the smelter, to contain a Gates rock-breaker plant, and a boarding house midway between the mine and smelter. Dynamite was kept in a locked box 500 ft. from the boarding house.

THE GERTRUDE MINE.

This mine was being developed by the Lake Superior Power Co. of Sault Ste. Marie, Ont., as a source of nickel ore for a new process to be inaugurated at Sault Ste. Marie. The superintendent of the mine was Thomas Travers of Sudbury. The mines are located five miles from Naughton on the "Soo" branch of the C. P. R., on the south half of lots 3, 4 and 5, concession 1 of Creighton, district of Algoma. The Gertrude shaft is on lot 3. It is vertical, 8 ft. x 12 ft. in cross section, and 52 ft. deep, cribbed to a depth of 31 ft. At the bottom is a drift 34 ft south. Hoisting is done by kibble with $\frac{3}{4}$ in. cable, running over a sheave on a square head frame. The power plant was located to one side of the shaft, and consisted of a temporary frame structure containing a 12 h.p. upright boiler, and a duplex hoist, with drums 14 in. in diameter. Six test pits of small dimensions have been sunk on outcroppings of ore, on lots 4 and 5 to westward of the Gertrude shaft. A diamond drill plant was working at the time of my visit (Sept. 8, 1899) 30 ft. north of the shaft. Dynamite was stored 200 ft. s.e. from the shaft and 120 ft. from the blacksmith shop in a log house, which was not locked. This was ordered to be removed to a place of safety, in accordance with the mining regulations, and to be kept securely locked. It was permitted to keep one day's supply in the existing magazine. The boarding house was 500 ft. west of the Gertrude shaft. A blacksmith shop and a stable were located about 200 ft. n.w. from the shaft.

The properties owned by Dr. Ludwig Mond, farther to the west of the Gertrude mine, were not undergoing development at the time of my visit to this district. The only exploration in progress at that time was by diamond drill borings.

CREIGHTON MINE.

This property, also known as the Stobie Falls mine, is situated on lot 10, concession 6 of Creighton, district of Algoma, opposite the Stobie Falls on the Vermilion river. It is owned by Robert G. Leckie and R. M. Thompson. The outcrop of the vein is at the water's edge, the vein dipping away from the river. A vertical shaft has been sunk 40 ft. from the river to a depth of 115 ft., with a cross section of 6 ft. x 8 ft. It is a single compartment shaft, with a manway. Cribbing has been carried down 30 ft. to solid rock. At the bottom is a crosscut 20 ft. s.s.w., which has not yet intersected the ore-body. Hoisting is done by kibble with a $\frac{3}{4}$ in. cable. The shaft house is 18 ft. x 36 ft., with a boiler room adjacent. A duplex derrick hoisting engine is used, having $5\frac{1}{2}$ in. x 8 in. cylinders. In the same room is a 3-drill Ingersoll air compressor. The boiler room contains two boilers of the locomotive type, made by the Waterous Engine Works, Brantford, each rated at 50 h.p. Pumping from the mine was done by a 12 in. x 8 in. x 4 in. Northey duplex pump. Dynamite was stored 40 ft. from the shaft house. It was ordered to be removed to a distance of 600 ft.

About three-eighths of a mile east of this mine was a small prospect tunnel in copper ore, 35 ft. long. In this deposit the copper pyrites occurred in a calcite gangue, quite at variance with its usual association in this region. This prospect was owned by Frederick Hamilton and others of Sudbury.

THE PARRY SOUND COPPER MINING CO., LTD.

The offices of this company are in Parry Sound, and in St. Paul, Minn. The board of directors consists of Frank Johnson, Robert Forbes, Otto Moreson, Wm. Faulke, and S. F. Pierce, all of St. Paul. The company has acquired the M'Gown mine in Foley township, and the Wilcox mine 14 miles s. s w. from Parry Sound. The workings at the M'Gown mine consist of a pit, a vertical shaft and an inclined shaft. The pit is on the shore of M'Gown lake, and is 40 ft. x 25 ft., and 20 ft. deep. A considerable quantity of bornite sufficiently rich for smelting has been selected and corded up beside the workings. The vertical shaft is located 400 ft. n. n. w. from the pit. This was in process of sinking and had reached a depth of 54 ft., with a cross section of 10 ft. x 11 ft. Timbers had been set to a depth of 26 ft, using 8 in. x 8 in. timbers, dividing the shaft into 4 compartments, two for hoisting being 4 ft. 6 in. square inside, and two for manway and pump column respectively, being 3 ft. 6 in. x 4 ft. 6 in. Hoisting was done by kibble with $\frac{1}{2}$ in. cable, running over a 20 in. sheave, mounted on a gallows frame 20 ft. high. The hoisting engine was a small duplex machine with 12 in. drum set in an open shed 30 ft. from the shaft. Steam was taken from a 20 h.p locomotive boiler in the same shed. The inclined shaft was 400 ft. w. of the main shaft, having an inclination of 25° from the horizontal, leaning w. 10° n. Its depth is 100 ft. Hoisting is done by car on a single track, operated by a windlass. The dynamite magazine is 1000 ft. n. of the main shaft. The day's supply is kept in a store house at the mouth of the inclined shaft. A blacksmith shop is located 75 ft. south of the main shaft. The company has purchased and was erecting a gold mill 60 ft. from the west shore of M'Gown lake. The plant is a regulation 10-stamp mill, with Frue vanners, supplied by Fraser and Chalmers of Chicago. The building is 63 ft. square, with a wing for the vanners. The power is supplied by a 60 h.p. return tubular boiler, and a 60 h.p. engine.

Southwest of the mill was a well equipped assay office, and a boarding house. Forty men were working at the time of my visit, (Sept. 11, 1899).

The Wilcox mine had not passed beyond the stage of a mere prospect, insufficient underground work having been done to admit of measuring up any ore bodies. A shaft had been sunk 38 ft., with a 9 ft. x 11 ft. cross section, hoisting by derrick and horse. The ores occur in a shear zone, in garnetiferous schist, with disseminated chalcopyrite and other sulphides said to carry some nickel. On the shore of the sound was a boarding camp, and at a distance of 500 ft. was a dynamite magazine.

The properties acquired by this company embrace the following: The M'Gown group, lots 24, 25, 26, and 27, concession 1, lots 22, and 23, concession 2, lot 16, concession A, in McDougall township, lots 146 and 147, concession A, and lots 142, 143, 144, 146, and A, concession B, of Foley, district of Parry Sound. The Wilcox groups consist of south half of lots 18, 19, 20, 21, and 22, concession 4, and lots 15, 16, and 17, concession 5, of Cowper. The Messagamashine group, lot 23, concession 8, and lot 23, concession 9, of Hardy. The M'Gown mine is on lot 146, concession B of Foley, the inclined shaft on lot A concession B of Foley, and the Wilcox mine on lot 22, concession 4 of Cowper.

THE HATTIE BELL MINE.

A local company in Parry Sound has been organized under the title of the Hattie Bell Copper, Gold, and Nickel Mining Co., with James B. Mitchell as manager. The mine, sometimes called the Lafex mine, is located on lot 35, concession A of Foley, district of Parry Sound. A vertical shaft has been sunk 65 ft., with a cross section of 6 ft. x 8 ft. At the bottom is a drift 10 ft. west. Hoisting is done with derrick and horse, using a wooden kibble. There was no manway, men being lowered and raised in the bucket. Dynamite was also kept carelessly, exposed to the weather, near the shaft. The installation of a ladderway in the shaft, and the provision of a magazine or waterproof locker for dynamite were ordered.

Additional prospecting for copper is going on throughout this region, where the outlook is not unfavorable for the development of workable mines. The most important of the new discoveries, which came under my notice was the McQuade property near Sans Souci, where bornite occurs massive and impregnated through an amphibole schist.

IRON FURNACES.

There are at present two iron furnaces in blast in Ontario, one making coke iron and one making charcoal iron. A third furnace for charcoal iron will soon be in blast at Midland, and a fourth is projected at Kingston, which will use coke. In spite of the encouragement which has been offered to utilize Ontario iron ores, practically all the pig iron produced is from ores imported from the lake Superior region. The difficulty would appear to be a lack of either courage, or of information as to proper mining methods, resulting in an effort to produce ore before the mines have been properly developed. In consequence the output is uncertain, and the ores coming almost wholly from near the surface are of uncertain iron-content. Many of the Ontario ores, especially in the eastern district, where alone they have been exploited to any extent, contain a considerable amount of iron pyrites, requiring careful sorting before shipment. At the Coe Hill mines, and also at other mines farther east, large quantities of ore have been thrown on the dump which it is claimed could be concentrated by the improved systems of magnetic separation and brought up to smelting grade. There would seem to be warrant for believing that if the high grade ores were sorted out, and the sulphurous ores crushed and concentrated, there are mines in the Province which could be operated on a fairly large scale. But even with this in view, extensive development work needs to be done at practically every iron location in Ontario. A large output is promised from the discoveries in Michipicoton mining division, but these have not yet been rendered available. The magnetite deposits along the line of the Kingston and Pembroke Railway have received considerable attention, and fitful shipments are made from that district; but here again the development has not been done which will enable any furnace to depend upon them for its ore supply. Moreover, when used unmixed with hematites these ores, on account of their great density, do not reduce with sufficient rapidity in the furnace, causing serious difficulty. An attempt is being made to weaken the structure of these ores by roasting, so as to enable them to be used in larger quantities. This experiment, which is being tried at Hamilton, will be of great interest.

HAMILTON FURNACE.

The present campaign of the Hamilton blast furnace commenced on June 19, 1897, and will continue until the spring of 1900, which is indication of good technical control. It is worthy of mention that the technical adviser at this plant was trained in Ontario (at the Kingston School of Mining). The furnace is 75 ft. high, 16 ft. in diameter at the boshes, 10 ft. at the crucible, and the same diameter at the throat. The blast is heated in a plant of 3 modified Whitwell stoves, 60 ft. high and 19 ft. in diameter. The temperature of the blast is 1300° F. The power house contains 12 boilers, 8 in constant use, each of 250 h.p., heated by waste gases. The two blowing engines are rated at 1200 h.p. each, the blowing cylinders 5 ft. by 7 ft. The stock sheds have a capacity of 50,000 tons of ore and stone, and the coke sheds have a storage capacity of 2000 tons. The cast house measures 48 x 150 feet, casting being done every four hours, 25 tons of metal at a cast. A new furnace is to be built promptly, and ground has been broken for a steel plant, which will contain a basic and an acid open hearth converter, of the William tilting type, of 15 tons capacity each. The ore used at Hamilton comes almost exclusively from the Mesabi range, the stock on hand showing the following composition:—

Moisture	12 to 14 per cent.
Iron	62 per cent.
Silica	3 " "
Alumina	1.5 to 2 per cent.
Lime (CaO)	0 25 "
Magnesia (MgO)	0.25 "
Phosphorus	0 07 "
Sulphur	0.005 "

Connellsville coke is used, coming by all rail. Considerable difficulty has been experienced in obtaining a high grade coke, with a uniform percentage of ash. This may be due to the present excessive demand for coke, causing the coke-makers to pay less regard to the quality supplied than would be the case in dull times when competition was keener.

DESERONTO FURNACE.

The Rathbun Co. of Deseronto put their new charcoal furnace into blast on January 25, 1899, since which time it has been in successful operation, making a high grade of iron, some of which has found a market in England. The furnace is 61 ft. high, 9 ft. 6 in. at the boshes, 7 ft. at the tuyeres, with a crucible 5 ft. 11 in. deep. A 75 h.p. vertical blowing engine is used, the blast being heated in a U-tube stove. The ores employed come from the lake Superior district, only small quantities of Canadian ores having been experimented with. The company's charcoal plant is of great interest. Both kiln burning and retorting are practised. There are 17 beehive kilns of red brick, 28 ft. in diameter and 20 ft. high. A tunnel in the bottom leads the vapors to the mains, which convey them to the copper tube condensers in the by-product plant. Each kiln holds 40 cords of wood, and burns three days. It is then allowed ten days to cool. Imperfectly charred wood constitutes 10 to 12 per cent. of the product, and 5 per cent. of breeze is made. The retort plant contains 50 steel retorts, 50 in. in diameter and 9 ft. long, set in fire brick, cased outside with common brick. The charge for each retort consists of $\frac{3}{4}$ cord of wood, which is retorted in 24 hours. Each pair of retorts has a separate heating chamber. There is no imperfectly charred wood, but the percentage of breeze is about the same as in the kiln-charring. This is mixed with tar condensed from the vapors, and is used for heating the retorts in conjunction with the gases, which, after passing through condensers at the back of the retort block are trapped and led back into the heating chambers. The charcoal is drawn into steel cars and smothered down with steel covers. For the operation of this plant a total force of 18 men is employed. The by-product plant is of the ordinary sort, producing 400 gallons of wood alcohol and $2\frac{1}{2}$ tons of acetate of lime *per diem* of 24 hours.

THE MIDLAND FURNACE.

The Canadian Iron Furnace Company, Limited, of Montreal, has acquired property on the north side of Midland harbor, consisting of an 80 acre strip having a half mile water frontage. The municipality of Midland has granted the company a bonus of $50,000, and exemption from all but nominal taxation on $25,000 for 10 years. Work was actively in progress, preparing for construction, in September. The plans provide for a 75 ft. furnace, $13\frac{1}{2}$ ft. at the boshes, $7\frac{1}{2}$ ft. in diameter at the crucible; 3 Whitwell stoves, 60 ft. high; 2 vertical blowing engines 5 ft. stroke, steam cylinder 36 in. in diameter, and air cylinder 84 in. in diameter. A wharf 400 ft. long is to be built, with 18 ft. of water alongside, and stock sheds as a continuation of this wharf. A by-product charcoal plant is to be erected with 60 circular kilns 30 ft. in diameter each. The woods available are mostly beach, maple and "iron-wood." It is estimated that the cost of hardwoods on the dock at Midland will be $1.25 per cord, and of soft woods $1.00 per cord. The company is hoping to secure its iron ore supply from Michipicoton, but it is in any case very favorably located for a cheap supply of the best ores in the world for a high grade pig iron. Among other advantages which the company points out is that Midland is as favorably located so far as the Lower St. Lawrence trade is concerned as Hamilton, for all transportation by rail, the length of haul from Midland to Montreal being practically the same as from Hamilton.

IRON MINES.

The development of the iron mining industry can not be said to have been satisfactory. The causes have been indicated in my remarks on the iron smelting industry. The thorough development of one good mine would give an impetus to all the others. It

must be said that the owners of iron mines in eastern Ontario have been unfortunate in the selection of managers, many of whom have proven unequal to the problems presented for their solution. But for this, the mine owners themselves are to blame. The failures made have led the mine owners to resort to the system of leasing to operators under a sort of tribute system, attended with its usual evils. In a region where mining has not developed to large proportions the tribute system is certain to lead to a mere gouging out of ore, with no regard to systematic work, which would leave the mine in condition for future economical production. The net result of the methods pursued has been to discredit the iron mines of the eastern district, which is most unfortunate. The geological occurence of some of these deposits at least is such as to warrant the belief that well-directed operations would put ore-bodies in sight which could be profitably mined.

THE BEDFORD MINE.

This mine, which is situated near the Zanesville P. O., has been intermittently worked, shipping small quantities of ore during the year. The old pit has been deepened to 35 ft, and a new inclined shaft has been sunk 64 ft., with a cross section of 15 ft. x 20 ft. One pump was working, and a new and larger one was being set up. A derrick hoisting-engine, with 8 in. x 10 in. cylinders was being used, taking steam from a 20 h. p. upright boiler. New plant had been ordered, which was expected to be installed during the autumn. There was a good surface showing of magnetite, mixed with some hornblende and calcite, and a new discovery had been made near by of phosphatic iron ore, for which a market could be obtained if a sufficiently large deposit could be placed in sight to insure a steady supply. Systematic development at the Bedford mine is certainly warranted by surface indications.

COE HILL MINES.

Experiments are being conducted at the Edison concentrating works at Ogden, N.J., and also at Dunbar, Pa., with ores from these mines, under the supervision of Mr. G. A. Longnecker of Mechanicsburg, Pa., and of Mr. John Morris of Dillsburg, Pa., in the hope of being able to utilize the Coe Hill ores. At the time of my visit (Nov. 4, '99), it was reported that the outlook for solving this problem was very favorable.

CALABOGIE MINES.

New development has been going on two miles by road east of Calabogie station on the Kingston and Pembroke Ry. The mines are situated on the east half of lot 16, concession 9 of Bagot, Renfrew county. This work has been in progress since April, 1899, under lease by the Hamilton Steel and Iron Co. from the owners, Boyd Caldwell & Co. of Lanark. The main working called the T. B pit was 30 ft. deep, 30 ft. in diameter at the top, and 15 ft. in diameter at the bottom. Hoisting was done by a derrick with a 40-ft. mast and 45-ft. boom, using an iron bucket of 1,200 lb. capacity for ore, and a wooden "flat" of 2,400 lb. capacity for waste rock. The engine house was 75 ft. east of the pit, containing a 12 h. p. boiler and engine with a single drum, winding a $\frac{7}{8}$ in. steel cable. Drilling was done with one Mack and one Ingersoll Sergeant drill, using steam, and the pit was kept unwatered by a 4 in. x 6 in. x 8 in. Cameron pump. Two other openings had been made, but were not then working (Dec. 8, 1899), known respectively as the Jeannette open cut, 200 yards west of the T. B. pit, and the Tommy R. pit, 700 yards west of the T. B. pit. Dynamite was stored in a log house half a mile west of the workings. Fulminates were kept in a store house near the camp. Thawing was done with a horizontal tubular thawer, in a small building near the mine, where the day's supply of explosives was kept. Other buildings were a boarding house, lodging houses, a blacksmith shop, carpenter shop and stable, located approximately 225 yards west of the T. B. pit. Instructions were given as to providing a manway and signal system at the T. B. pit.

THE CALABOGIE MINING CO.

This corporation, with offices at Perth, had sunk a pit 60 ft. deep, 200 ft. east of the T. B. pit, which was abandoned, and full of water at the time of my visit.

THE ROBERTSVILLE MINES.

These mines had been working at infrequent intervals. In the Lizzie mine drilling with two drillers had just been commenced on Dec. 9, 1899. In the interval since my last visit another hole had been broken through from the upper to the lower stope, 20 ft. west of the skipway. During the summer the lower stope had been pumped out by the Hamilton Steel and Iron Co., but had been allowed to refill with water. The Ferguson pit had been deepened to 35 ft., on a 35° angle. The pit had been widened out to 25 ft. in the winning of ore. The surface plant remained unchanged. This property was being operated on lease from H. A. Ferguson of Kingston to F. W. Schwendiman and Thomas Barnes. The dynamite magazine had been removed, according to previous instructions, to a point 400 ft. south of the Ferguson mine.

EQUITABLE MINE.

A company has been formed to work certain deposits of iron ore occuring in the vicinity of Dog lake, in Storrington township, Frontenac county. Operations at the time of my visit (Oct. 19, 1899) were confined to an outcrop in Potsdam sandstone on lot 20, concession 10 of Storrington. The workings consisted of an open cut into the hill, with a working face 31 ft. 6 in. high, and having a length of 39 ft. and a width of 32 feet. On the top of the hill 25 ft. south of the open cut was a pit 15 ft. deep. Seventy-five tons of ore had been piled up ready for shipment. Transportation from this point can be accomplished by barges running from Dog lake to the Rideau canal. The dock is situated 300 ft. from the open cut, having 18 ft. of water alongside. No permanent plant or buildings had been installed.

Prospecting was in progress at many other points in this locality, the most advanced of which was on the Ennis farm on lot 14, concession 9 of Storrington, where an open cut had been driven 18 ft. with a width of 20 ft., having a breast 10 ft. high.

WILBUR MINE.

One of the best developed iron properties in Ontario is that known as the Wilbur mine, about two miles from Lavant. It is situated on the line of the Kingston and Pembroke Ry., from which a siding a half mile long has been built. There are four pits in all, located as follows: No. 1, on lot 4, concession 12 of Lavant, Lanark Co.; No. 2, ditto; No. 3, on lot 4, concession 13 of Lavant; No. 4, ditto. The owner is Mr. William Caldwell, of Toronto. The mine is being developed by a force of 18 men, under the superintendence of Samuel Jackson. In the process of development which has been carried on in No. 3 and 4 pits 5000 tons of ore have been extracted, with an estimated iron content of 58 per cent.

The several pits are located along the outcrop of a magnetite deposit, with crystalline limestone on the footwall, and gneissoid and schistose rocks on the hanging side. The latter show some intrusions of felsitic dikes. Between both the foot and hanging walls of the deposit are bands of amphibole schist. The magnetite contains some calcite, but is remarkably free from silica and pyrite.

Pits No. 1 and 2 were worked in times past, but are now abandoned. Preparations however are being made to pump out pit No. 2 and continue development there. The largest amount of work recently done has been confined to pit No. 3. An open pit, 300 ft. long, was originally made, averaging about 20 ft. in depth. At about mid-distance in this an inclined shaft was carried down at an angle of 38° to a depth of 90 ft., with a cross-section of 15 ft. x 12 ft. extending toward the s. s. e. At this depth a drift was run 70 ft. straight ahead, which then turned eastward 105 ft. to a stope of irregular shape, 30 ft. by 40 ft. From this stope an old drift 230 ft. long connects with the abandoned workings of the old pit No. 1. An inclined upraise has been driven from the stope to the bottom of the open pit, which is to serve in future as the main shaft. Thirty feet west of the stope is another drift, southwards from the east and west drift, extending 56 ft. in ore. There is also a "break-through" from the bottom of the present shaft to the old stope, a distance of 90 ft., thus leaving a block of ore 70 ft. by 100 ft. (average and 25 ft. high. At the bottom of the shaft is a direct acting duplex pump, 4″ x 5″ x 6″,

built by A. R. Williams & Co., Toronto. In the old drift eastward, 100 ft. from the stope, is another duplex pump. A tramway extends from the bottom of the shaft around to the stope. Pit No. 4, 400 ft. w. s. w. from No. 3, was opened in the same manner, with an inclined shaft s. s. e., on an angle of 30°, with a depth of 96 ft. This at present is not working. The main power house is situated 200 ft. e. n. e. from shaft No. 3. It is 40 ft. x 37 ft., with a woodshed 12 ft. x 12 ft. It contains a 60 h.p. return tubular boiler, a 3-drill air compressor, built by the Morris Machine and Iron Co., Dover, N.J., a 6 ft. x 3 ft. receiver, carrying an air pressure of 60 lb., and a double-cylinder, single-drum hoisting engine, built by Barber & Co., Allentown, Pa. This winds a 1 in. cable, running over idlers to the shaft mouth, where it turns at right angles into the shaft.

An oil house 9 ft. x 8 ft. is located 100 ft. e. n. e. of the engine house. A dry house, well provided with all conveniences, is situated 35 ft. s. w. from the engine house, and 95 ft. farther on is a blacksmith shop, 24 ft. x 16 ft. A small hoisting engine in a 12 ft. x 12 ft. frame building is located 40 ft. n. n. w. from the mouth of shaft No. 4. Steam is piped to this from the main power house. The dynamite magazine, storing one ton of dynamite, is located on the side of a hill 500 ft. w. n. w. from the power house. It is built of logs, surrounded by a dry-wall of stone. A thawing house was situated 120 ft. w. n. w. from shaft No. 3, heated by a stove. No thawer was used. The dwelling houses begin at a distance of 700 ft. w. n. w. from the engine house. A Sullivan diamond drill was set up 600 ft. south of pit No. 3. One hole had been bored previously between this point and the pit. The depth of hole at the new location was 45 ft. The outlook for a permanent industry here is encouraging. Recommendations were made as to the proper care of dynamite, and a brake was ordered to be attached to the hoisting engine in the main power house.

NATURAL GAS.

The natural gas producing area of Ontario is at present limited to the counties o Essex and Welland. In Essex county the producing horizon is confined to the Clinton limestone, which is reached at depths of from 950 ft. to 1000 ft. from the surface. The wells in this district vary from 965 ft. to 1033 ft. in depth. The rock dips toward the north at the rate of about 75 ft. to the mile. It is assumed that the rocks from which gas is now obtained constitute the northern slope of an anticlinal fold, whose axis passes somewhere near Pelee island in lake Erie, a well on that island reaching the gas rock at a depth of 700 ft. Accordingly the desirable locations for wells on the mainland are as near to the lake shore as possible. Less than a mile inland the wells become practically unproductive, or at best have but a short productive life, speedily becoming drowned out by an influx of salt water. It is now proposed to make borings on Pelee Point, so as to tap the gas rock as near the anticlinal axis as possible. While it is true that the yield is more satisfactory the farther south the wells are located, there appear to be areas, even in the zone which is worked, which are less productive than others, or which fail to yield gas at all. This seems to be due to the character of the rock, which varies considerably in porosity at different points. There are thus distinct reservoirs of gas, determined by the amount of porosity. The largest flow of gas is naturally obtained from such reservoirs, but on the other hand these suffer exhaustion sooner than those where the gas rock is relatively more dense. The salt water having risen into this porous rock is rather slowly expelled, as gas again accumulates by flowing in from the adjacent territory, so that recovery is tardy, and never permanent. A "drowned" well, after being shut off for a period, may again yield gas for a short time, but usually it will flow gas for only a few hours at most, when it will begin to spout water. The influx of water takes place as soon as the gas pressure becomes reduced to about 100 lb. per square inch, though in some wells a reduction of pressure to 200 lb. admits the water. In the earlier days of the field the "rock pressure," that is, the pressure of the gas, was 400 lb. per square inch. It has now been reduced to 350 lb., and is slowly but constantly lowering. In exhausted or "drowned" wells the salt water rises to within 75 ft. of the surface.

In Welland county the gas-yielding horizons are the Medina sandstone and the Clinton limestone, most of the wells drawing from the Medina formation. The dip of the rocks here is 30 ft. to the mile toward the southeast, but there is no anticline toward which the gas may accumulate. The wells vary from 850 ft. to 1100 ft. in depth. In this district no difficulty is experienced by an influx of water, but the pressure is declining. Ten years ago the "rock pressure" was 430 lb. per square inch, which has now been reduced to 173 lb, and in some parts of the field to 125 lb. "Shooting" the wells seems to produce an increased flow of gas in very few instances, although this practice has been resorted to with some advantage in a few wells owned by the Essex Standard Oil and Gas Co. in Essex county.

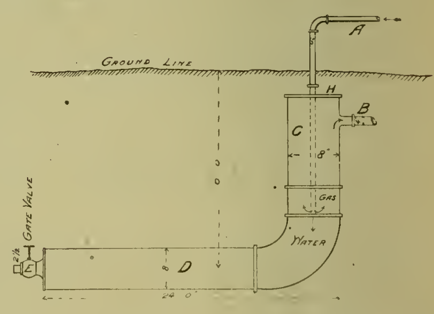
The composition of the gas shows some differences in the eastern and western fields, those in Welland county generally containing appreciable quantities of nitrogen, and in one well at least a considerable amount of hydrogen sulphide. An analysis of the gas from the Point Abino well, made by Prof. Francis C. Phillips of Allegheny, Pa., showed the following composition :—

Hydrogen sulphide	0.74	per cent.
Nitrogen	2.69	"
Carbon dioxide	trace.	
Hydrocarbons of the paraffine series	96.57	"
	100.00	

The percentage composition of these paraffines by weight was :—

Hydrogen	24.10	per cent.
Carbon	75.90	"
	100.00	"

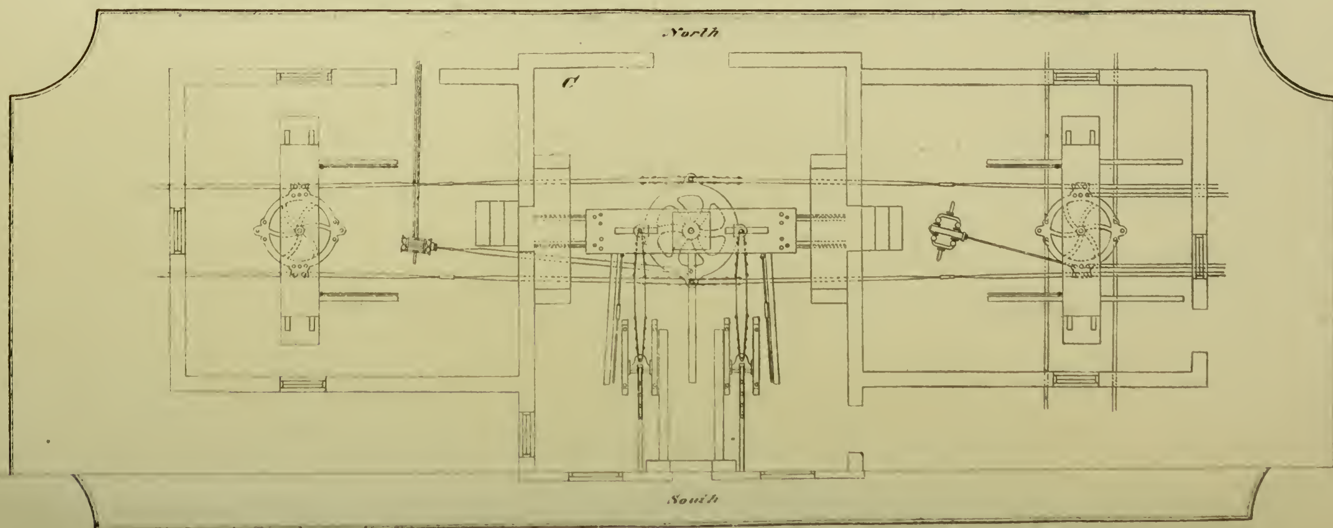
This gas was found at a depth of 550 ft. below the surface.

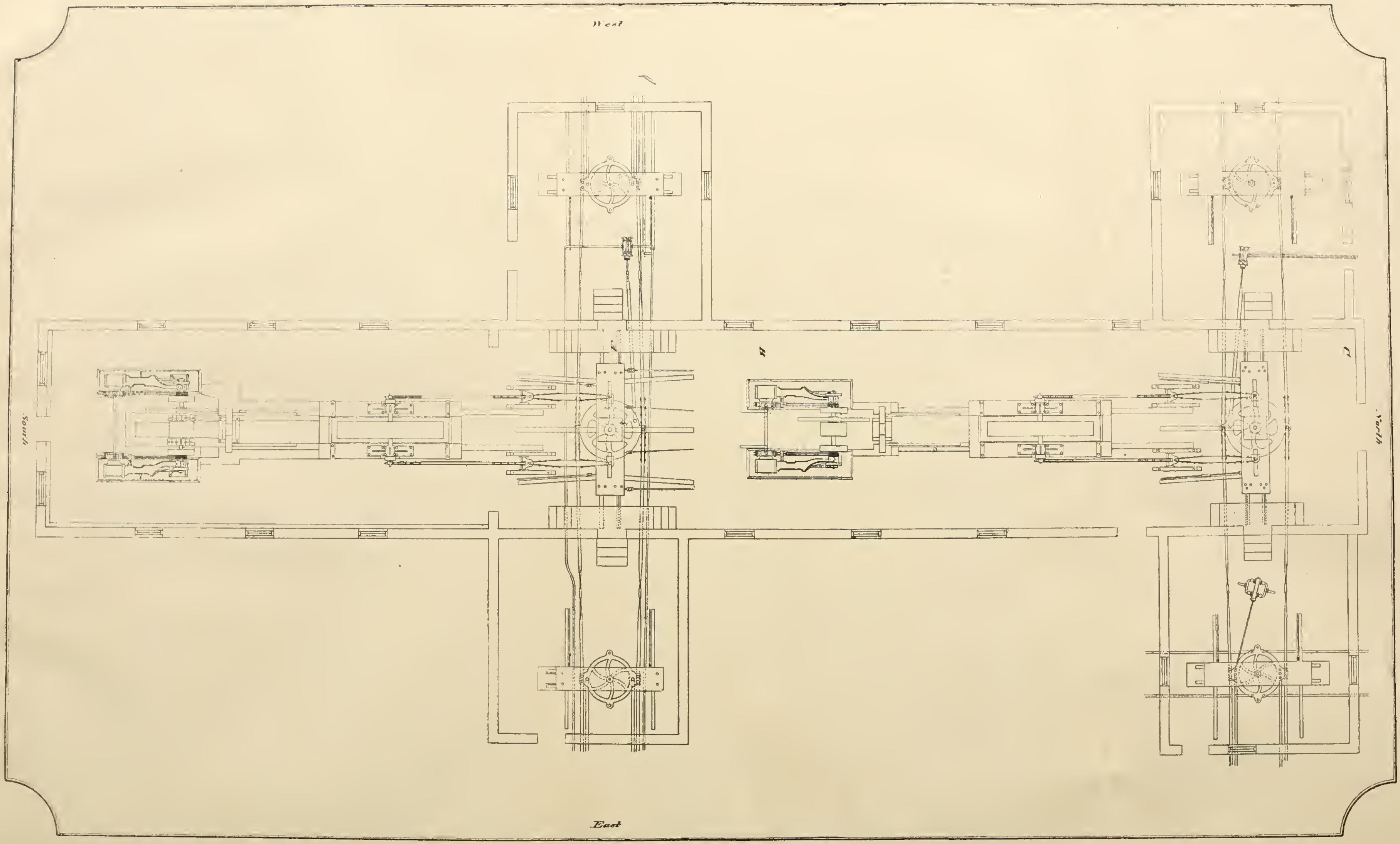


The amount of moisture requiring elimination from the gas is much less in the Welland than in the Essex field. No drifts are used in Welland county, but at intervals the accumulation of water in sags on the gas line is drawn off. In Essex county a form of drip, differing in some respects from those commonly employed in gas fields, has been designed and put in operation by Mr. Harrison Smith, field superintendent for the Natural Gas and Oil Company of Ontario, Ltd. This is shown in the accompanying diagram. The gas main, A, is led through a drum-head, H, concentrically into an 8-inch vertical pipe, C. The pipe C is carried to a depth of 6 ft. below the post line, and then turns at right angles, being continued 24 ft., terminating in a reducer with a 2½ inch gate valve for drawing off the water which accumulates in the horizontal portion of the drip tube. The gas main, A, terminates 4 ft. from the drum-head, and the gas flows up through the 8 inch pipe and issues through a 4-inch main, B. In expanding as it passes from the 3-inch main into the 8-inch pipe, the gas parts with most of its moisture, which falls into the horizontal portion of the large pipe.

Drilling in the gas fields is done almost exclusively by the American system, with ropes instead of with rigid rods. The rod system is more rapid to shallow depths, but is slower and more expensive when depths exceed 600 ft.

In Welland county considerable gas is employed for burning lime, but most of the gas is exported, both from this and from the Essex field. By an Order in Council the exportation of gas from Essex county is to be restricted after three years from August 1st, 1898, to that required for consumption in the city of Detroit, and during these three years it is limited to three billion cubic feet per annum.


North
a
South



Plan of J. L. Englehart's Pumping Rig at Petrolea, p. 107.
Scale: 13½ feet = 1 inch.

PETROLEUM.

The report of the Bureau of Mines for 1898 gives the situation in regard to petroleum production so fully that practically nothing remains to be said on this point. In the Petrolia district 45,000 to 50,000 barrels per month are being pumped, and the new Sarnia township field along the London Road was pumping 2,000 barrels per month at the time of my visit in September, 1899. Drilling was still actively going on in the old districts, and torpedoing was giving good results in increasing the flow in many old wells. The shallow depth of the wells in this field admits of drilling a great number of holes over a small area, without entailing prohibitive expenses. The average depth of wells is from 465 ft. to 480 ft. The well-drilling contractors undertake to drill a well for 475 ft. to 500 ft. for $125, furnishing their own fuel, water, labor and conductor pipe. The hole is drilled with a diameter of $6\frac{1}{4}$ in. through the watery strata, and is then continued, after casing has been put in, with a diameter of $4\frac{5}{8}$ in. for the dry hole. The contractor puts in the casing, which is furnished by the owner of the well. He also leaves the derrick and machinery from 24 to 48 hours after the well is drilled, for testing. During this time the well is torpedoed, from 8 to 25 quarts of nitroglycerine being used for this purpose. The derricks are very substantially built, 50 ft. in height, and are transported from place to place on trucks. The engine house is similarly built for removal on trucks. The rigid rod system is employed entirely for drilling by this method. The contractor puts in the pump before leaving, and sets up a three-pole derrick over the well for handling the pumps and piping.

Deep drilling in the Petrolia district was contemplated, in which case wells would be drilled about 3,000 ft. to the Trenton limestone, seeking either oil or gas. As a preliminary to the carrying out of this plan, the question of a franchise for supplying the town with gas was to be submitted to the people. Deep drilling was also to be undertaken at Inwood by a private corporation, consisting of parties connected with the Standard Oil Co., which company has bonded all the land in that vicinity.

The pumping system which has been developed in these oil fields differs in some interesting particulars from that in vogue in Pennsylvania. A good example of the system is that in operation by J. L. Englehart & Co., at Petrolia, where one central power plant pumps from 233 wells scattered over an area of 400 acres (see Plan). It is a balanced system, half of the dead load of rods and mechanism in the field being lifted while the other half is descending, so that the power required is only that for overcoming inertia and friction, plus the weight of the oil lifted at each stroke. Counterweights are thus superseded, reducing the mass of material to be moved, giving in consequence a higher efficiency for the horsepower expended. In the case of the Englehart plant, four engines coupled in pairs, each of 40 indicated horsepower, serve the entire group of 233 wells. These two pairs of engines are connected to two main or "master" wheels, which, in addition to direct connections to pumps, operate 22 secondary or "local" wheels, controling two jerker rods each. These wheels are large discs set horizontally, cast with four lugs at the ends of two diameters at right angles to each other. Each lug carries two wrist pins for connecting the jerker rods. The wheels have a reciprocating motion imparted to them, swinging through an arc long enough to give the jerker rods the necessary forward and backward motion to produce the proper length of stroke at the pumps, which is communicated to them in the ordinary way by walking-beam or triangle-arm connections. The jerker rods are of wood with spliced joints, suspended from posts by pin-connected hangers of iron, these rods, in conjunction with the pump rods, serving as the counterbalance in the system. The pump rods are of gas pipe, $\frac{3}{8}$ inch pipe being used with a $1\frac{1}{4}$ inch pump, and $\frac{1}{2}$ inch pipe with a $1\frac{1}{2}$ inch pump, their average length being 475 ft. At the Hillier farm, eight miles east from Sarnia, there are two systems of pumps, of 84 and 26 wells respectively, pumping from a depth of 480 ft. The wheels used here, instead of being cast, are made of two discs of $\frac{3}{16}$ in. boiler iron bolted parallel to each other with two inch spaces between. The lugs are then riveted at their proper places on the circumference of the wheels. This field has been opened but one year, and gives excellent promise.

CEMENT.

During the year I visited three of the works in the Province where Portland cement is manufactured. The localities where these industries flourish are in the vicinity of Owen Sound, and to the northward of Napanee in the eastern district. Hydraulic cement is made in the vicinity of St. Catharines, near Hamilton, and at Limehouse, but these works were not visited.

THE OWEN SOUND PORTLAND CEMENT COMPANY, LTD.

The officers of this company are: John Lucas, president, J. E. Murphy, vice president, R. P. Butchart, general manager, George S. Kilbourn, secretary and treasurer, and W. H. Pearson, director. The works are located at Shallow lake, 9 miles from Owen Sound. The raw materials, marl and clay, are here found together, the clay underlying the marl, the deposit constituting the bed of Shallow lake, which overflows the entire area in the spring time, but dwindles to a small size later in the season. The material is dug by a steam excavator and loaded directly upon cars, running on temporary tracks leading to the inclined plane by which they are elevated 40 feet for dumping upon the stock pile. The cars are drawn by animal power to the foot of the incline, where they are hitched to a cable connected with a winding engine, which carries them to the top. There are two winding engines with 3 ft. drums and duplex 7 in. x 9 in. cylinders. The details of the process of cement making in these works are not given to the public, but in general it may be said that the wet system is employed. After grinding and mixing, the pulp is standardized and then pumped to the drying chambers, and thence transferred to the kilns for burning. At present the "slurry," or burnt cement, is passed through crushers and then ground in tube mills with Baltic quartz pebbles. Krupp ball mills are being installed for intermediate comminution between the crushers and tube mills. The power plant consists of 4 boilers of 150 h. p. each, two made by Cowan and Co. of Galt, and two by the John Doty Engine Co. of Toronto; one Reynolds Corliss compound condensing engine, 500 h. p., one Brown engine, 300 h. p., and one high speed 30 h. p. engine for driving a 10 k. w. dynamo

The company has acquired other property in the vicinity, on which new works will be erected with larger capacity than those now operating.

THE GEORGIAN BAY PORTLAND CEMENT CO., LTD.

This company has lately been organized. and was erecting a large plant on the S. E. side of the bay in the municipality of Owen Sound. The works lie between the tracks of the C. P. R. and the water. A slip is being provided which will have 18 ft. of water by the wharf. The personnel of the company is as follows: Presdent, M. Kennedy, vice-president, H. B. Harrison, sec. and treas., J. W. Maitland, A. G. McKay and S. Lloyd, directors. The capital stock is $95,000, of which $85,000 is paid up. The marl is to be obtained from Williams lake, 13 miles distant on the C. P. R., near Holland Center station. Its analysis shows:

Lime carbonate	95 to 97	per cent.
Alumina and iron oxide	0.38	"
Insoluble residue	3.15	"
	98.53	

The clay is found on the opposite side of the bay, where 7½ acres have been acquired with a bank averaging 23 ft. in depth. The analysis of the clay is:

Loss of ignition	12.16	per cent.
Silica	51.52	"
Alumina and iron oxide	23.18	"
Lime (CaO)	10.92	"
	97.78	

The principal buildings already erected are the main building 200 ft. x 60 ft., the dry house 140 ft. x 100 ft., and the storage house 300 ft. x 60 ft. The process will be as follows:

The raw materials, in the proportion of 1 of clay to 4 of marl, will be mixed for 15 minutes in a battery of 3 mixers or wet pans of the Chilean-mill type, except that the pan revolves beneath the rollers. The rollers are 48 in. long and 14 ins. in diameter, the pan having a diameter of 9 ft. and a depth of 16 in. In the bottom of the pans are renewable liners. The pulp is discharged to a conveyor which carries it to a horizontal pug mill, where it is stiffened by the addition of ground cement-brick. This prepares it for pressing in an ordinary brick machine. The bricks are stacked on iron "pallets" and set in a skeleton steel car which is run into the drying oven. The Cummer direct-heat hot air system is employed, this part of the plant being installed by the F. D. Cummer and Son Co. of Cleveland, Ohio. After drying, the cars are taken to an elevator which lifts them to the charging floor of the kilns. The burning plant consists of 4 Aalborg kilns, each 100 ft. high, 20 ft. in diameter at the bottom, 4½ ft. at the throat and 15 feet at the top of the hopper. From the kilns the burnt bricks are carried by a conveyor to two Jenisch and Loehnert's ball mills, supplied by F. L. Smidth and Co. of Willoughby, Ohio. The material is here reduced to No. 24 brass-wire mesh. The pulverizing is done in a Davidsen's tube mill, 24 ft. long by 5 feet in diameter, using Baltic quartz pebbles. In this mill the cement is ground to pass a No. 100 mesh screen. The power plant consists of 3 return tubular boilers, 14 ft. x 5 ft. 6 ins., 100 h. p. each, and a 350 h. p. compound condensing engine made by the Goldie & McCulloch Co. of Galt. Tests made on cement produced from the materials to be used in this plant show the following strength :

Briquettes, 2	days old	190 lb. per sq. in.	
" 4	"	440	"
" 5	"	525	"
" 6	"	640	"
" 18	"	675	"
" 30	"	750	"

NAPANEE MILLS CEMENT WORKS.

The Rathbun Co. of Deseronto is operating a large cement works at Napanee Mills, under the superintendence of F. G. B. Allen. The raw materials, both marl and clay, come from Marlbank, a station 15 miles farther north on the Bay of Quinte Railroad. The system of manufacture pursued here is substantially the same as that which will be put in operation by the Georgian Bay Portland Cement works at Owen Sound. The mixing of the pulp is accomplished in two drag-mixers 25 ft. in diameter, with 4 plows each, attached by chains to revolving arms. From this the pulp passes through a tube mill with ½ inch steel balls. It is then standardized, and part passes to a revolving dryer and part to a pug mill, where the dried "slurry" is reunited with it to stiffen it for pressing in the brick machine. The bricks are then dried in a Cummer dryer, burnt in kilns and ground to No. 20 mesh in a Smidth Ball Mill, and subsequently to No. 100 mesh in a tube mill with Baltic quartz pebbles. The revolving dryer mentioned above is a cylinder fitted with angle plates projecting on the inside to carry the pulp up and cause it to fall through the current of hot air passing through the cylinder. Two types of kilns are used, the burning plant consisting of 2 Aalborg kilns and 2 batteries of Dietsch kilns, built in pairs, back to back. In the latter the bricks fed in at an upper vertical stack pass down to an inclined bench or offset in the furnace, and thence into a lower vertical shaft where the burning is finished at a high temperature. These works produce two brands of cement known as "Star" and "Ensign" respectively. The capacity of the plant is something over 100,000 barrels per annum.

STONE QUARRIES.

A number of quarries were visited during the year, some of which were of peculiar interest from the methods employed in working out the stone. No effort has been made to visit all the quarries in operation, owing in part to their large number, and in part to the circumstance that many of them are not working continuously, so that trips

to them are made fruitlessly. There is very little danger of serious accidents at the great majority of quarries, the operations being of so simple a character, and the quantities of explosives kept on hand being usually so small.

THE OWEN SOUND STONE CO., LTD.

This corporation has the following officers: Pres't., H. B. Smith, sec. and treas., S. J. Parker, and manager, P. W. Sabiston. The chief quarry is known as the Mono, situated in Mono township, Dufferin Co., 4 miles northeast of Orangeville on a spur of the C P.R. The product is a very compact, light gray sandstone, and is extensively quarried for bridge and building stone. There are five benches, varying from 4 ft. to 7 ft. in thickness. Only one bench is now being worked, this having a thickness of 6 ft. The workable stone is overlaid by 15 ft. of thin-bedded limestone and 15 ft. of soil. The sandstone itself presents some remarkable examples of cross-bedding, which interferes somewhat with the systematic development of the benches. In spite of these difficulties the quarry is well laid out and operated. Three derricks, with 60 ft. masts are used, operated by horsepower. At one time an inclined plane was used for hoisting the stone to a sawing and planing plant, but this has now been abandoned and the dressing works are dismantled. The only other buildings are a blacksmith shop and an office, in one part of the latter being kept a small supply of powder.

NOTTAWA QUARRY.

The same character of stone as that found in the Mono quarry is being worked out in a small quarry ¼ mile to the southeast, by the owner, Isaac Nicholson. There is less super-jacent limestone and soil at this quarry, and the stone is of a high quality. It is expected to open this out shortly on a larger scale. There were two derricks set, having masts 45 and 55 ft., and booms 40 and 45 ft. respectively. The buildings consist of a blacksmith shop and an office, in which is kept the supply of explosives, consisting of one keg of powder. The quarry is on lot 6, concession 1 of Mono.

SMEETON'S QUARRY.

In the vicinity of Inglewood are a number of quarries, of which Smeeton's is the only one now working. This is situated 1½ mile s. w. of Inglewood. The benches operated consist of brownstone, 2 ft. thick, underlaid by gray sandstone from 2 to 3 ft. thick, each opened about 500 ft. in length. Three horsepower derricks were being used, and drainage was effected by a duplex steam pump. The magazine was located 800 ft. from the workings. Two car loads of curbing *per diem* were being shipped at the time of my visit, Sept. 19, 1899.

A visit was also made to Thomas Murray's quarry, 1½ mile northwest of Inglewood, but it was found to be abandoned. A tramway extends from Inglewood to this quarry.

D. ROBERTSON AND CO'S. QUARRY.

One and a half miles east of the Forks of the Credit in Caledon township is the quarry of D. Robertson & Co of Toronto. There are 4 benches working, yielding both gray and brown stone, the brown strata lying above the gray. Three derricks were set up, and a force of from 20 to 30 men were employed. The shipments amount to about 12 carloads of curbing a week. The stone is sent in trams down a 3 rail incline, 500 ft. long, to the siding on the railroad track (C.P.R.) at the bottom of the hill below the quarry. The cable makes 3 laps around a drum 5 ft. in diameter, the cable ends being attached to cars. The drum is provided with band friction brakes. The foreman in charge is F. A. Lumby.

THE CREDIT FORKS MINING AND MANUFACTURING CO.

The above company, with offices in Toronto, is operating a number of quarries at the Forks of the Credit, and has been operating lime kilns at the same point. These are now closed, and work at the quarries was nearly suspended at the time

of my visit on Sept. 19, 1899. Preparations, however, were being made for extensive quarrying. The quarries are located on both sides of the deep gorge through which flows the Credit river, and are situated high up on the hillsides. An aerial tramway was in process of construction to convey stone from quarry No. 5 on the hill north of the village to the station on the C.P.R. (Toronto, Orangeville and Elora Div.). The operations of this company are of peculiar interest from the circumstance that for many years a portion of the stone extracted has been obtained by mining. The method of mining resembles that in use for coal, although the workings are of comparatively small extent. Two entries are driven into the face of the hill about 150 ft. apart. At a distance of from 25 to 40 ft., varying according to the strength of the rock, these entries are connected by a cross-drift. The winning of rock then commences. The brown sandstone constitutes the bottom bench. The upper bench is limestone, and between these two is an intermediate bench of shale, which forms the " bearing-in " bench. After its removal the limestone is shot down, and then the brownstone is extracted in the ordinary way. The working face is 160 ft. wide, and protection against roof-falls is afforded by temporary stulls The culls, or waste, is thrown back between gob-walls, so that the gob (locally called "dirt") advances close enough to the working face to prevent collapse of the roof. An entry is kept open on each side of the gob, so that cars can enter through one and return to the surface by the other. It will be seen that by this system the cost of quarrying is little, if any, greater than in ordinary open quarries, and is very much less than in those where much stripping of surface debris is required The officers of the company are, Pres't., Robt. Carroll, vice-pres't, J. B. Vick, sec., treas. and mgr., F. Beharriel, all of Toronto.

During the summer another small mine, extracting brownstone, was operated by W. Sharp, but this was closed in September.

SALT.

During the year a careful inspection of the salt industry was made, and subsequently analyses of samples of salt and brine have been conducted under my supervision by Mr. J. W. Wells at the Provincial Assay Office, Belleville. The results of my investigations, and of the analyses and experiments made at Belleville, will be given later in a separate report. The salt works visited were the following :—The Coleman Salt Co., Seaforth ; R. & J. Ransford's Stapleton Salt Works, Clinton ; North American Chemical Co., Goderich ; The Goderich Salt Works, of Peter McEwen, Goderich ; The Gray, Young and Sparling Co., Wingham ; The Ontario Peoples Salt Co., Kincardine ; John Fox and King Hodgins Salt Works, Park Hill ; The Sarnia Salt Co., Sarnia ; and The Windsor Salt Works, Windsor.

PEAT.

An inspection was also begun of the peat industry in Ontario, and numerous localities were visited. Tests of the peat are also being made at the Provincial Assay Office, Belleville, and the results of investigations in the field and the laboratory will be made the subject of a special report. The Canadian Peat Fuel Co., of Toronto, has given a strong impetus to this industry, which promises to become one of great importance to the Province.

MICHIPICOTON MINING DIVISION

By D. G. Boyd, Inspector

I have the honor to present to you herewith the third annual report on the Michipicoton Mining Division. During the past season the district has made steady advances in many directions. More development work has been entered upon, and, in the majority of cases, is proving very satisfactory. Mining machinery has been set up, of which the following may be mentioned,—A one stamp mill complete, on Claim No. 84, the property of the Hornblende Mining Company, and on the Minto mine, the property of the Wawa Gold Mining Company, a pumping and hoisting plant.

Post offices have been established at Wawa, Michipicoton River and Michipicoton Harbor (the lake terminus of the Algoma Central Railway). The Government road has been built between Little Gros Cap on lake Superior and Wawa village, and several good tote roads have been made by the miners to the various camps. In prosecuting work upon Helen claim, situated about one mile north of Wawa lake, an extensive body of brown hematite ore was uncovered, attention being thus drawn to this locality. The iron-bearing formation was traced a long distance, and numerous claims have been staked upon it.

Information reaching the Department that large bodies of valuable iron ore had been discovered in this Division, the Government resolved upon a temporary withdrawal from sale of these iron-bearing lands, pending an investigation with a view of ascertaining the extent of the ore deposits and obtaining other desirable information. This was pursuant to the provisions of an Order in Council, dated 10th July, 1899.

Dr. Coleman and Professor Willmott were appointed to make this investigation, and their summary report is given in the 8th Report of the Bureau of Mines, pp. 254 258. The withdrawal of the iron lands accounts for the large number of licensees who have not any claims registered, as they located claims in the iron-bearing lands in expectation of obtaining the claims staked when the lands are placed in the market again.

The Algoma Central Railway began construction of a railroad from Little Gros Cap to the Helen mine above mentioned, a distance of 12 miles. Ore docks will be built in the harbor, and it is expected that iron ore will be shipped continuously during the coming season.

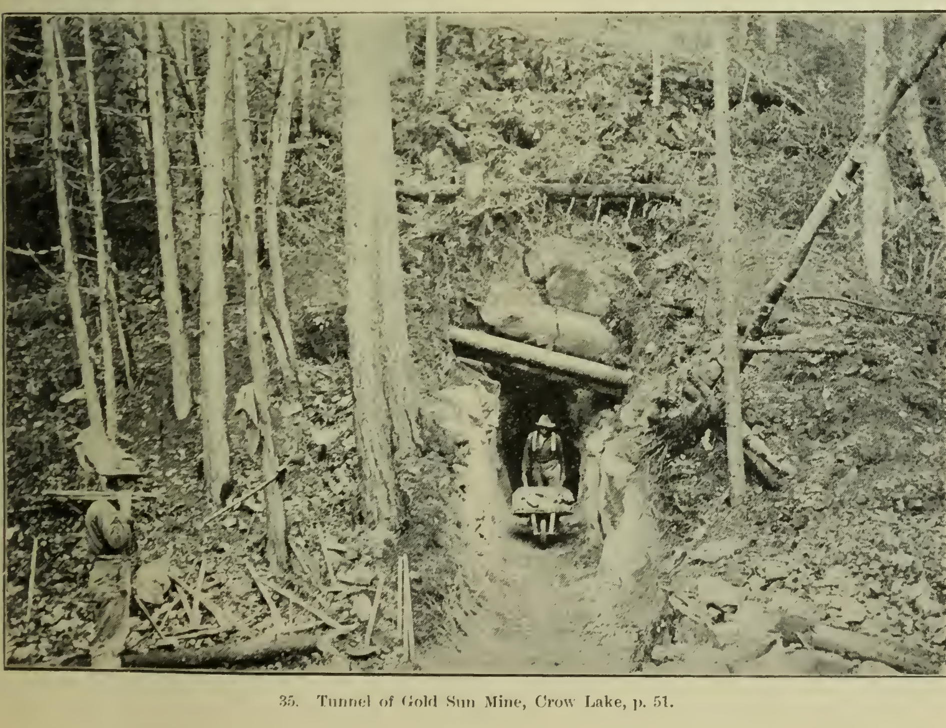
The office at Michipicoton was opened for the transaction of business in one of the Hudson's Bay Company's buildings (the same one as occupied in 1898) on May 16, and continued open until November 14. During this period there were 187 miners' licenses issued, and 181 notices of mining claims filed.

The total number of licenses issued, including renewals for the year, was 252, 65 being issued from Toronto. The total number of claims staked and registered was 215, of which number 33 were registered at Toronto while the office at Michipicoton was closed during the winter months. The amount of money forwarded to the Treasury Department from the office at Michipicoton was $3,014, and the amount received at Toronto was $1,965, making a total of $4,979. Of this amount, $2,520 was received for miner's licenses, $1,059 fees for additional mining claims, $315 fees for transfers of claims, and the balance $1,085 was paid in on account of patent fees at the rate of $2 per acre by licensees who have fulfilled all the conditions required and desire to obtain a patent fer their property.

Claims numbers 155, 156, 451 and 468 were visited by me on the 12th October. These claims are situated south of Wawa lake, and about five miles east of Michipicoton river, with which they are connected by a good tote road. The claims are being developed by the Edey Gold Mining Company of Ottawa, Limited, with Mr. R. W. Edey as manager, and John Wallace of Sault Ste. Marie as foreman. Work was commenced in the early part of spring and continued all season.

On claim 155 a shaft 7′ x 8′ x 25′ deep has been sunk on the Blackinton vein, (so called after the discoverer), having a course of northwest and southeast, which has been traced through claims 155, 156, 451 and 319. The vein on this claim has been stripped n several places, and varies from two to eight feet wide on the surface.

34. Tunnel and Shaft of Stella Gold Mine.



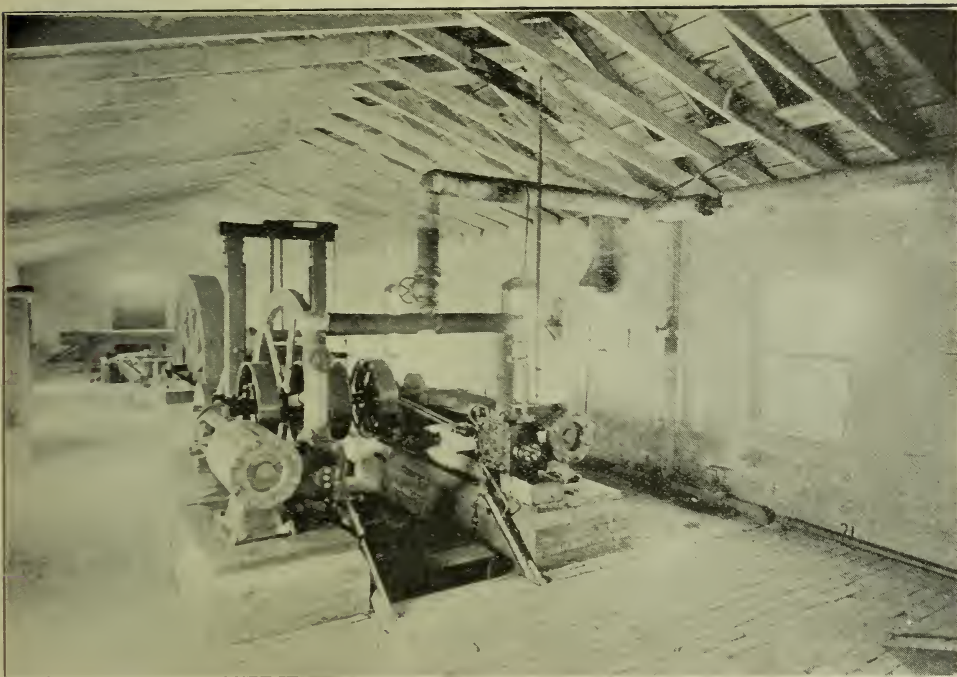
35. Tunnel of Gold Sun Mine, Crow Lake, p. 51.

36. Steel River Rapids near Ursa Major Gold Mine, p. 83.

37. Falls on Steel River at Mountain Lake, p. 83.

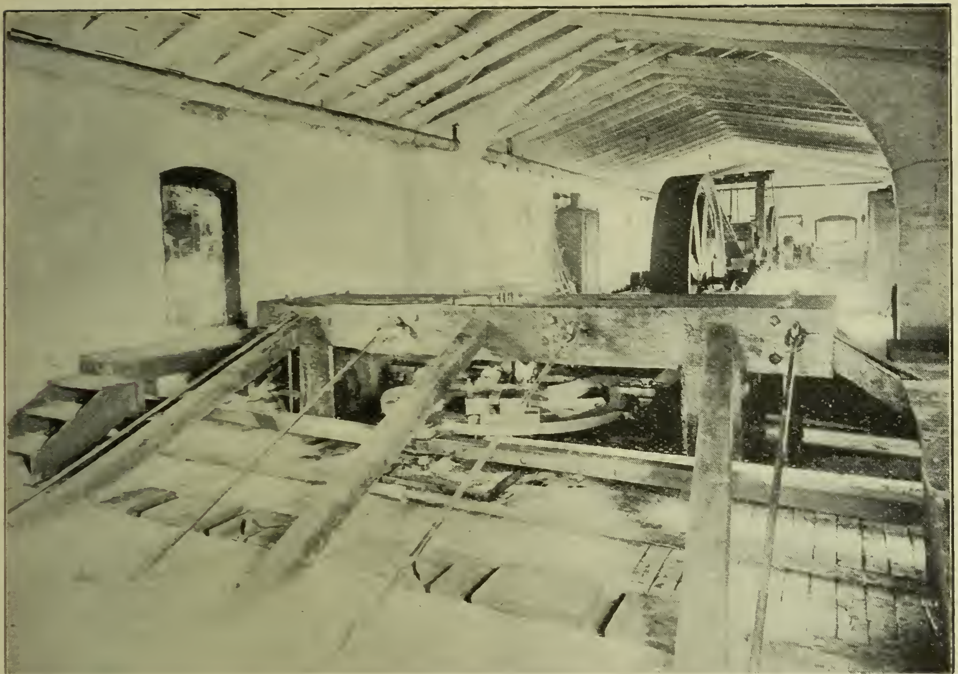
38. Open Quarry Work at Upper Pit on Lizard Vein, Ursa Major Gold Mine, p. 83.

39. Ursa Major Gold Mine, Shaft and Cross-cut, p. 83.

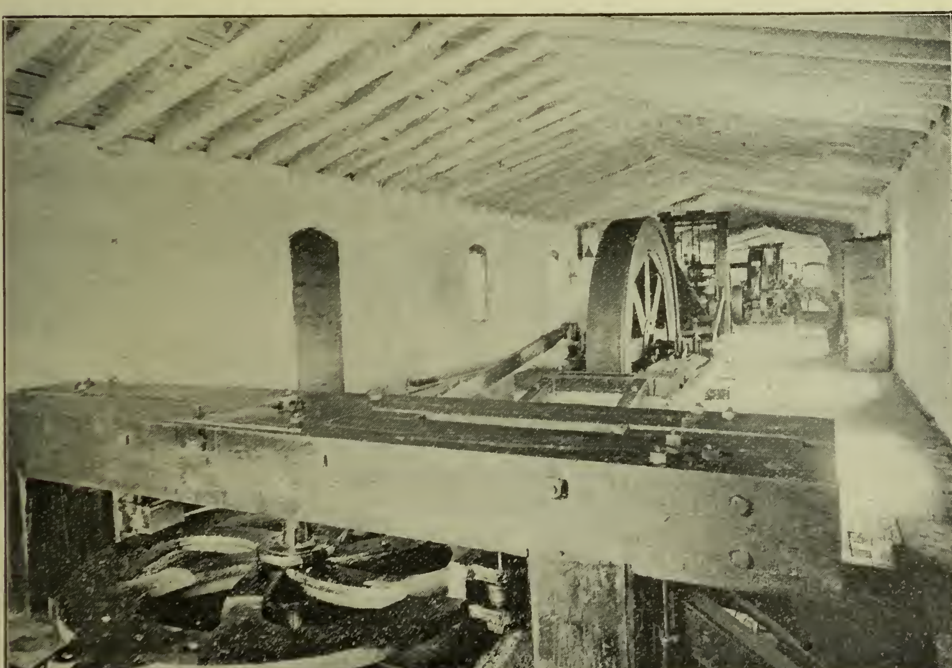


40. Power Plant of the Englehart Pumping System at Petrolea, looking south from " A " on Plan of Pumping Rig, p. 107.

41. Power Plant of the Englehart Pumping System at Petrolea, looking north from " A " on Plan of Pumping Rig, p. 107.



42. Power Plant of the Englehart Pumping System at Petrolea, looking south from "B" on Plan of Pumping Rig, p. 107.



43. Power Plant of the Englehart Pumping System at Petrolea, looking south from "C" on Plan of Pumping Rig, p. 107.

On claim "Lyla," No. 451, on the vein having a course nearly north and south, two shafts have been sunk seven by eight feet; one 23 feet deep, the other 11 feet deep. Besides the above mentioned shafts, the Edey Company have done considerable work in stripping and sinking test pits. A combined sleeping and cooking camp 18 by 20 feet, blacksmith shop and workhouse have been built.

On claim 447, situated three miles east of Michipicoton river, the same company have also sunk a shaft 7′ x 8′ x 57′ deep, timbered down to a depth of 12 feet, and also have erected camps.

Claims No. 31 to 36, 502 and 503 were visited by me on October 19th. These claims are situated north of the Wawa lake, and were purchased by A. C. Ely of Chicago from A. Goetz. The work was combined on these claims and performed on claims 69 and 502. Mr. J. R. Van Evera of Marquette, Michigan, was manager, and he had with him as captain Mr. W. O. Uren. These claims are situated on the iron range and the work done was exploratory.

On claim 69 a shaft 8′ x 10′ x 21′ deep was sunk in the country rock on the south side of Boyer lake, at the foot of a large hill.

On Claim 502 a trench 300 feet long, two feet wide, was dug down to the solid rock across the iron formation, and a test pit 5′ x 7′ x 6′ deep was also sunk.

On R733 (surveyed) a pit 8′ x 6′ x 16′ deep was sunk, and a tunnel 7′ x 6′ x 24′ long was driven, both being in the country rock, and a trench 800 feet long and three feet wide was dug across the iron formation

Close to the line between claims 68 and 502 a trench 100 feet long and three feet wide was dug, and a pit 5′ x 7′ x 6′ deep was sunk.

None of these operations disclosed the presence of any ore body. The properties are being thoroughly tested by a diamond drill during the winter.

Claim No. 68 "Helen Iron Mine", was visited on 19th October. This property has been described by Dr. Coleman, see Bureau of Mines Report for 1899, pp. 254-255. It is owned and managed by Mr. E. V. Clergue, who has Mr. T. Williams as captain.

The development consisted in stripping off the earth, moss, trees, etc., which covered the deposit, sinking nine pits 7′ x 3′ from 4′ to 24′ deep, and determining the extent of the deposit. On the southern boundary a tunnel 6½′ x 4′ x 45′ long, has been driven.

On the point in Boyer lake, where the bulk of the ore is, two open cuts have been made, one on the north side 100 feet long, 20 feet wide and 25 feet face, and on the south side 100 feet long, 40 feet wide and 30 feet face. A drift has been started in the ore on a level with Boyer lake, 7½′ x 5′ x 24′ long. The camps used during the summer were built for temporary occupation.

Claim "Lincoln," No. 415, was visited on 25th October. This claim is owned by Andrew Brown of Sault Ste. Marie, who has charge of the work. The vein is a contact one between the two formations. Its course is northwest and southeast, dipping 45 degrees to the north. The average width of the vein on the surface is 4 feet; it is well mineralized with iron and copper pyrites with frequent showings of free gold. One shaft 6′ x 8′ x 35′ deep has been sunk, and 400′ southeast of the same vein another shaft 6′ x 8′ x 20′ deep.

An eating and cook camp 16′ x 30′, sleeping camp 15′ x 20′ and blacksmith shop have been built. A contract for 100 feet of additional sinking in pit No. 1 has been let to Messrs. Brown and J. B. Johnston, which will be done this winter. The property is under an option for sale to a company composed of Bowling Green, Ohio, parties.

Claim "Peru", No 315, situated on the same vein was visited on the same day. The vein has been traced across the claim and stripped in several places. A pit 6′ x 7 x 13′ deep has been sunk. This claim is owned by Mr. R. Rush of Echo bay, who had his brother, Mr. W. Rush, developing his claim.

Claims 300, 494 and 564 were visited on 13th October. These claims are part of a group which are owned and operated by the Guelph Mining Company, Limited. Mr. Wm. Husson is in charge On claim 300, on a vein 4 feet wide, with a course of about east and west, a pit 6′ x 8′ has been sunk 14 feet deep. On claim 494, a pit 6′ x 7′ x 27′ deep has been sunk on a vein which has been traced through three claims on a course of

northeast and southwest, well mineralized with iron and copper pyrites. On claim 564, a pit 6′ x 8′ x 30′ deep has been sunk on a vein which has been traced for 20 chains, and which varies from 4 to 6 feet wide, with a course of northwest and southeast; it dips to the northeast and is well mineralized.

"Gananoque," claim No. 128, is owned by the Gananoque Gold Mining Company, Limited, with Joshua Legge in charge. A tunnel at the foot of a hill has been driven 5 feet wide and 14 feet high, a distance of 34 feet, following the course of the vein. Half way up the hill another tunnel has been driven 7′ x 8′, 22′ into the country rock to try and catch the vein. A large amount of work was done in clearing off the overhanging rocks above the tunnel at the foot of the hill.

Claim No. 480, is owned by the Corona Mining Company, Limited, with Mr. W. H. Wylie as manager. On a large vein with a strike of west-northwest and east-southeast, which has been traced from Wawa creek across to Michipicoton river, the vein matter is about 180 feet wide, consisting of a mixture of quartz and slate. A shaft 6′ x 8′ x 23′ deep has been sunk all in quartz, which is heavily mineralized with iron and copper pyrites, with traces of mispickel and zinc blende. A camp 16′ x 28′, and blacksmith shops have been built. On the same vein, on claim 634, situated on Wawa creek, a tunnel was driven 13 feet. Claim "Cora," No. 26, is owned by H. W. Evenden, and worked by the Johnston brothers of Sault Ste. Marie, Ontario. On a vein, course nearly north and south, dipping 43 degrees to the east, two shafts have been sunk, the southerly one being 8′ x 10′ x 32′ deep. The other is 100 feet north, and is 9′ x 12′ x 16′ deep. A camp and blacksmith shop have been built. This claim was visited October 30.

On claim 84, visited October 30, and owned by The Hornblende Mining Company, Limited, a shaft 7′ x 7′ x 22′ deep has been sunk. A stamp mill has been erected, and the following machinery installed,—15 h. p. engine, 16 h. p. upright boiler, small Blake crusher, Nissen's ore feeder, Nissen's gravity stamp, 1,300 pounds, with a capacity of from 6 to 7 tons per day of 24 hours. The special feature about the mill is that it has a circular mortar. The mill building is 16 by 27 feet. At the time of my visit all the machinery was up and connected, but had not been in operation. Sleeping and cooking camps were built, and the office and manager's house were being erected. Mr. P. N. Nissen is manager.

On claim 52, which is owned by the same company, a shaft 6′ x 8′ x 32′ deep has been sunk. It was the intention of the company to put in another mill as soon as possible.

At Mackey's Point, Y 103, at the time of my visit on October 30, the pits were full of water. The following particulars were given to me by Mr. J. J. Mackey. A shaft 8′ x 10′ x 40′ deep has been sunk, and at the 40 foot level a crosscut 6′ x 8′ x 30′ long has been run. Another small pit is down 6′ x 8′ x 14′. Cook and sleeping camps have been built.

Claims 92, 93, 94 and 95, the Minto mines, owned by the Wawa Gold Mining Company, Limited, were visited on October 30. Work was mostly preparatory for mining on a large scale. A working shaft was sunk on the edge of a small lake, 6′ x 11′ x 42′ deep. This has been timbered to a depth of 25 feet, with an excellent collar. The following buildings were erected,—cook and dining camp and root house, 24 by 36 feet, store-house, 16 by 20 feet, sleeping camp, 1½ stories, 16 by 30 feet, office 1½ stories, 20 by 20 feet, shaft-house and dry-house, 18 by 30 feet, blacksmith house, 14 by 16 feet, stables, 17 by 27 feet and engine house 14 by 16 feet. The following machinery was installed,—18 h. p. engine with hoisting attachment and upright boiler; also Northey pump with a capacity of 150 gallons per minute.

On the Jubilee claim No. 75, the shaft was sunk to a depth of 103 feet during the winter. The work was suspended all through the summer.

Other properties were visited, but the work done was not of sufficient importance to be noted here.

Appended is a list of licensees, place of residence, number of license, and number of claim (if any). Where not otherwise indicated the licensees are residents of Ontario. Claims marked with an asterisk (*) are in dispute.

LIST OF LICENSEES.

Name.	Residence.	License No.	Claims.
Abell, J	Toronto	523	278, 373, 676.
Allan, J	S. S. Marie	618	684, 685, 686.
Allan, J. G	Hamilton	554	608.
Andrie, G	Michipicoton River	578	
Andrie, Mrs. G	"	655	
Armstrong, H	"	506	629.
Armstrong, H	Iron Mountain, Mich	500	
Armstrong, L. O	Montreal	460	
Bacon, B. T	Chicago, Ill	600	
Barton, S	S. S. Marie	648	533, 688.
Bartlett. E. T	Montreal	517	613, 637.
Bauldry, W. J	Wawa	577	
Beaudro, G	Wawa	586	
Becker, O	Michipicoton River	570	642, 652.
Beebe, W. D	Pleasantville, Penn	508	555, 627, 694.
Beirnes, J	Guelph	526	
Blackinton, A. B	Michipicoton River	637	282.
Bole, B. P	Cleveland, O	601	
Bousquet, J	Wawa	656	
Bowden, J. L	S. S. Marie	687	
Bowie, N	Wawa	591	
Boyd, J. F	Thessalon	471	377, 651.
Boyd, W. S	S. S. Marie	683	258.
Boyer, B	"	641	360, 425.
Brooks, Annie	Michipicoton River	519	571.
Brooks, T. H	" "	518	587.
Brotherton, G. H	Port Arthur	582	
Brown, A. F	S. S. Marie	659	113, 415, 696, 697.
Brown, Jane	"	544	535.
Bryan, H. J	"	569	650, 675, 690.
Burley, T. S	Missanabie	487	582.
Bush, C	S. S. Marie	681	273, *542.
Bush, jr., C	Hamilton	552	607.
Bush, Flora	"	553	
Cameron, A	White River	626	
Chitty, A. H	S. S. Marie	686	
Clark, E. D	Guelph	672	200.
Clergue, B. J	S. S. Marie	605	
Clergue, E. V	"	548	68, 70, 71, 190, 191, 510, 511, 512, 513, 514, 515, 516, 584, 585, 600, 667, 700.
Clergue, F. H	S. S. Marie	562	671, 703.
Clergue, Frances	Bangor, Maine	708	
Clergue, Gertrude	"	699	
Clergue, Grace	"	698	
Clergue, Helen	"	697	
Clergue, J. H	"	606	
Cochrane, R. B	Marquette, Mich	565	618, 680.
Conlon, J. A	Thorold	587	
Corona Mining Co., Limited.	Almonte	545	434, 480, 322, 417, 617, 633, 644, 662.
Cory, E. N	Pennville, Indiana	579	657.
Coughlin, R	Michipicoton River	546	606, 658, 659.
Culbert, D. S	Wawa	489	276, 528, 529, 545.
Davidson, J	Ottawa	677	129, 547, 616, 665.
Derry, P. A	S. S. Marie	566	416, 538, 539.
Dion, Mary L	Wawa	480	508, 572.
Donovan, H. A	"	485	668.
Douglas, E. A	Michipicoton River	510	575, 602.
Douglas, E. V	Philadelphia, Penn	700	
Douglas, J	S. S. Marie	537	578.
Douglas, P	Hawick, G. B	680	
Douglas, W. P	Philadelphia, Penn	702	
Downey, L	Chapleau	563	469, 492, 683.
Dowrie, R	Guelph	458	
Dreany, A	North Bay	581	
Drew, T. F	Wawa	755	702
Driver, J	S. S. Marie	567	380, 588, 589.

LIST OF LICENSEES.—*Continued.*

Name.	Residence.	License No.	Claims.
Drummond, H. A	Toronto	484	612.
Dunn, C. B	Paterson, N. J	568	
Dycie, J. G	Michipicoton River	498	490, 648.
Dycie, Margie	"	711	628.
Eccles, Ida	S. S. Marie, Mich	525	701.
Edey Gold Mg. Co., Limited	Ottawa	488	451.
Edey, M. C	"	673	155, 594, 656, 673.
Edey, R. W	Michipicoton River	675	468, 475, 447, 595, 654, 674.
Ely, A. C	Chicago, Ill	535	31, 32, 33, 34, 35, 36, 69, 502, 503
Emmerson, J. T	Port Arthur	595	
Enniskillen Mg. Co., Limited	S. S. Marie	630	669, 670.
Evenden, H. W	Campement D'Ours	462	26, 27.
Everett, H. L	Philadelphia, Penn	634	450, 454, 455, 471.
Flanagan, J	Wawa	468	660.
Fee, G	North Bay	670	
Fleming, S. E	S. S. Marie	619	682.
Gananoque Gold Mg. Co	Gananoque	609	128, 264, 269.
Ganley, Jas	S. S. Marie	496	581, 630.
Ganley, Jos	"	642	
Gaudette, C	"	521	299, 583.
Gemmell, L. J	Perth	467	
Georgi, J	Michipicoton River	610	537.
Gilmore, D. B	Toledo	513	275.
Gilmore, S. M	"	668	199, 465.
Gilmore, W	"	514	332.
Godon, T	Missanabie	547	354.
Goetz, A	S. S. Marie, Mich	611	631.
Goetz, G	Detour, Mich	572	
Goetz, Johanna	"	461	
Goetz, Mary	"	571	
Goetz, Mrs. P	S. S. Marie, Mich	613	
Goetz, Ruth	"	612	
Gravell, A	S. S. Marie, Ont	551	381.
G. N. M. E. & D. Co., (Ltd.)	Toronto	491	38, 75, 103 (⅔ int. in each) 449, 486
Grover, M. B	Wawa	479	
Guelph Mg. & Dev. Co	Guelph	682	202, 300, 494, 495, 563, 564, 566, 604, 621, 706, 620.
Hagedorn, C. K	Berlin	706	
Hall, W	S. S. Marie	559	
Hall, C	"	666	
Hamilton, H. C	"	703	
Hamlin, F	Chicago, Ill	665	
Hamwell, A. M	S. S. Marie	689	
Harrison, W. L	New York (city)	667	
Harvey, A	Chapleau	628	292.
Harvey, J	Hamilton	594	
Hassard, A	Toronto	472	609.
Holbrook, B	Wawa	564	530.
Holbrook, Leila J	Watford	588	693.
Holding, R	Kingston	477	570.
Holliday, W	Port Arthur	608	
Hopkins, Anna J	Pleasantville, Penn	507	72, 97.
Hopkins, H. J	Buffalo, N.Y	679	99.
Hornblende Gold Mg. Co., Limited	Toronto	486	84, 52, 487, 493, 504, 505, 529, 599
Hunt, J	Rydal Bank	625	491, 509, 626.
Husson, W	Guelph	671	202, 517.
Irving, T. C	Toronto	662	
Irving, jr., T. C	Michipicoton Harbor	663	
Johnston, A	Pembroke	541	168, 169 (½ int. in each) 590.
Johnston, T	S. S. Marie	629	541.
Jelley, J	Webbwood	685	
Kimball, Hattie	Michipicoton River	638	418, 534.
Kimball, Wm	"	497	551.
Kitely, H	Toronto	646	462.

LIST OF LICENSEES.—*Continued.*

Name.	Residence.	License No.	Claims.
Labelle, J	Michipicoton River	504	536, 550.
Lands Corpor'n of Mich'n., Limited	Toronto	645	
Laughton, M	S. S. Marie	575	
Lauzon, A	"	457	1 int. in 38 & 75, $\frac{1}{12}$ in 103, 408, 560
Law, S	Guelph	502	
Lawlor, J	Salem, Oregon	511	573, 598, 624, 641.
Lawlor, J. H	S. S. Marie	652	$\frac{1}{8}$ int. in 38 & 75, $\frac{1}{12}$ in 103, 681,687
Legarde, F	Michipicoton River	490	
Legge, C. H	Gananoque	644	522, 678.
Legge, J	"	639	521, 160.
Lewis, jr., A. E	Milford, Penn	635	178, 427.
Lewis, F	"	532	430.
Lewis, F. I	Philadelphia, Penn	701	
Lewis, W. H	Detour, Mich	538	318, 319.
Lincoln, J. C	Bowling Green, Ohio	543	580.
Mackey, J. E	Wawa	631	
Mackey, J. J	"	657	
Mackey, R. E	North Bay	669	
Madge, P	Thomes Road	466	666.
Malcolm, W	Collingwood	503	548, 558, 559, 640.
Manitou Mineral Co	Niagara	654	634, 643, 661, 689.
Martin, H. G	Wawa	636	647.
Maxwell, C. F	St. Thomas	531	553, 610.
May, E	Michipicoton River	528	325, 695.
Mead, F	Flushing, Ohio	617	672.
Merrick, W. C	Cleveland, Ohio	603	
Miller, R. J	St. Thomas	530	554, 611.
Mitchell, J	Guelph	501	520, 565, 622.
Mitchell, Mary E	"	520	567.
Monsarrat, N. S	Cleveland, Ohio	602	
Moran, P	S. S. Marie, Mich	622	
Moran, Mrs. P	"	623	
Morin, J	Hamilton	473	518, 543.*
Morris, Zoie	Morrisonville, Ill	573	
Murray, T. H	S. S. Marie, Ont	493	574, 576.
Murray, W. P	Cleveland, Ohio	597	
McCue, W	Wawa	592	
McDougall, L	White River	627	
McDougall, W. H	"	590	
McGillivray, W	Ottawa	674	156, 592, 597.
McGrath, M	Michipicoton River	709	
McHardy, J. A	Guelph	459	
McKay, Annie	S. S. Marie	576	
McKeehan, H. H	Cleveland, Ohio	593	
McLean, A	Wawa	469	
McLeod, D	Guelph	527	
McMichael, A. F	Toronto	515	615, 635.
McRae, P. J	Detour, Mich	539	347, 456.
Newton, G. J	Guelph	556	
Noel, J	Missanabie	463	317, 531, 532.
O'Brien, W	S. S. Marie	529	298.
O'Hara, J. C	Duluth	615	
Osborne, C. S	S. S. Marie, Mich	640	437.
Parkes, Mrs. A. W	St. Catharines	483	524, 527.
Parr, Mrs. S	Battle Creek, Mich	589	699.
Pattee, G. I	Michipicoton Harbor	653	
Pellow, H	Chapleau	550	601.
Perry, W. F	Wawa	549	
Pilkie, R	S. S. Marie	692	
Pimm, C	"	481	
Pol, B	Bangor, Maine	664	
Pol, Josephine	"	696	
Pol, Frances	"	707	
Preneval, G	S. S. Marie	492	561, 632.
Quigley, G. B	Bowling Green, Ohio	660	195, 579.

List of Licensees.—*Concluded.*

Name.	Residence.	License No.	Claims.
Ralph, M	Duluth, Minn	536	623.
Reed, G	Michipicoton River	658	653, 707.
Rogers, G. H	Ottawa	676	593, 655.
Rogers, J. W	S. S. Marie, Mich	540	
Roth, F	Cleveland, Ohio	678	253.
Russell, A. L	Port Arthur	596	
Rush, R	S. S. Marie, Ont	478	336, 540.
Sayer, J	Garden River	620	308.
Saults, Mrs. W. W	Goderich	482	526.
Scott, J	Nipigon	558	
Seneca Gold, Copper & Nickel Co., Limited	Welland	534	457, 458, 459.
Seymour, W. L	Chicago, Ill	599	
Simmons, N	S. S. Marie	494	519.
Simpson, N	"	704	
Sjostedt, E	"	560	704, 705.
Sleeman, G	Guelph	475	
Smart, T. K	Wawa	470	507.
Smith, R. H	"	474	
Snell, W. M	S. S. Marie, Mich	649	691, 692.
Snider, E. B. W	St. Jacobs	705	
Steese, R. C	Youngstown, Ohio	464	500.
Stewart, J	Pembroke	542	168, 169 (½ int. in each.) 591.
Stone, R	S. S. Marie	691	
Superior Gold & Copper Co.	Toronto	647	461.
Sutherland, J. G	S. S. Marie	688	
Swift, H. S	Duluth	661	
Talbot, H. E	Dayton, Ohio	607	
Talbot, K. H	"	616	
Teare, J. H	S. S. Marie	505	577, 619, 625, 646.
Thibault, N	"	533	337.
Thompson, D. S	Hamilton	555	603.
Thompson, F	S. S. Marie	693	
Thompson, R	"	694	
Towers, T. A. P	"	621	664.
Townley, W. B.	Toronto	516	614, 636.
Travers, R	S. S. Marie	624	
Trembley, Jos	Toledo, Ohio	643	49.
Van Evera, J. R	Marquette, Mich	604	
Vansickle, W. B	Lynden	499	301.
Walker, J. W	Creemore	509	552.
Wallace, J	S. S. Marie	522	549, 596.
Ward, A	Botona, Iowa	574	
Ward, L. M	Wawa	650	98, 378, 556, 568.
Ward, Myrtle	Pleasantville, Penn	651	460.
Ward, Venia, A	"	476	546.
Ward, W	"	495	281, 391, 569.
Warren, S	S. S. Marie	690	
Washington, S. F	Hamilton	512	*544.
Wheeler, C. P	Chicago, Ill	598	
Wick, H	Cleveland, Ohio	465	499, 501.
Wight, J	S. S. Marie	684	226.
Wilde, J. A	"	561	
Wiley, F. S	Port Arthur	584	
Wiley, H. A	"	583	
Wilfing, F. J	S. S. Marie, Mich	633	102.
Wilson, W. J	Michipicoton River	557	
Wilson, W. J	S. S. Marie	614	444.
Worthington, C. P	"	695	
Wylie, W. H	Niagara	680	586, 649, 698.
Younkin, F	Jackson, Mich	632	387.

ARE THERE DIAMONDS IN ONTARIO?

By Archibald Blue.

In this last decade of the century it has been dawning upon ourselves, and more slowly upon other people, that Ontario is a mineral country. In former times our own people were led to believe that they must depend on the resources of the field and the forest for livelihood, and there was no lack of proofs that for the farmer and the lumberman our Province was an ideal land for large possibilities. I am sure there was not in the whole of America another country of equal extent where there grew trees of such girth and height as in the tracts lying between the river St. Lawrence and the Ottawa, between lake Ontario and Georgian bay, and between lake Erie and lake Huron. Within the lifetime of one man that great forest has been cut away, and in its place are fertile fields, producing sustenance for two millions of people, and much for export besides Moreover, the farmer of today is a manufacturer as well as the producer of raw materials. He is not now content with growing wheat, oats and hay, as the pioneer was, and depending on his surplus of these crops for the profits of his industry. He converts grass and grain into beef, pork and mutton, poultry and eggs, butter, cheese and wool; and so earns a second series of profits, saves on freight, and keeps up the fertility of his soil Mixed farming and intensive farming go together, and although larger results are possible, it is gratifying to know that, as compared with any other Province or State on the continent, Ontario is easily first. This is one thing established by eighteen yearly reports of the Bureau of Industries, and if that Bureau had done nothing else it would have justified its raison d'etre, its right to be. There has been given to our people a reason for settled confidence in the lands they till and the country they occupy; and, in so far as these convictions go, we have the assurance of a stable population. In the New Ontario of the north there remains a region of much greater magnitude to occupy and possess, and in its resources of soil and timber another two millions of people may find support and occupation But if to soil and timber be added its unopened stores of minerals contained within an area of 100,000 square miles, and if the manufacturing idea takes possession alike of miner, woodman and husbandman, one can only say that we have the domain for a great Kingdom.

Taking the Old and the New Ontario together, there is a mineral bearing belt that extends 1000 miles, from the river St. Lawrence to the Manitoba boundary. It is the backbone of the world, and has borne the stress and strain of unnumbered cataclysms. It is a mountain built country, where the mountains have been cut down to hills, and the hills to plains. The thickness of some of the older formations is measured in miles, and they have been twisted, folded, fractured, crumpled during the long ages of secular cooling into more forms than fancy can conceive or pen describe. There are great areas of igneous as well as sedimentary rocks, and almost everywhere throughout the wide country are to be seen conspicuous evidences of disturbance, deformation, degradation and reconstruction. It is just the character of country in which a keen prospector for minerals would expect to find them in quantity and variety, and during this decade he has been awarded with discoveries from one end of the belt to the other. Nickel and copper, iron and gold, graphite and mica, may be said to occur abundantly. Corundum also is now proven to exist in a tract of 400 or 500 square miles in extent, and where corundum is we may hope to find the gem forms of it, sapphire and ruby. There is, however, one mineral of the first rank of utility which we have not. Our Province emerged too early from the sea, and has stayed too persistently out of it, to favor the coal measures. We have neither anthracite coal nor bituminous. But may it be possible that in the bounty of Nature's compensations we have the pure carbon element in its gem form, the diamond? Are there diamonds in Ontario?

Interest and curiosity in this question have been aroused by papers published during the past year in two American magazines of good repute as scientific authorities. In the Journal of Geology for May-June Professor William Herbert Hobbs of the University of Wisconsin has dealt with it in an article entitled the Diamond Field of the Great Lakes; and in Appleton's Popular Science Monthly for November the same writer

discussed it in an article on Emigrant Diamonds in America. He had also written upon it in 1894 in the American Geologist, and has referred to it in other publications. Briefer notices have appeared at intervals in official reports and scientific records during a period of more than thirty years of isolated discoveries of diamonds in earth beds, rock debris and drift deposits in the Atlantic, Pacific and Northern States, and mention may first be made of these as having precedence in the order of time.

DISCOVERIES IN THE UNITED STATES.

There are newspaper accounts of the finding of diamonds in Virginia and North Carolina nearly fifty years ago; but the most authentic reports are in a paper by Dr. Genth on the Minerals of North Carolina, published in the Journal of the Franklin Institute, November and December, 1871. The suggestive statement is there made that the diamonds were discovered in debris of old gneissoid rocks, in which graphite is always found. George F. Kunz of New York, who is an expert on precious stones, gave in the volume of Mineral Resources of the United States for 1883-4 accounts of a number of discoveries of diamonds in California, which usually were found in gold mines when cleaning up sluices or while washing off the bed rock, though in a few instances they were picked up on the surface. Fragments of diamonds had also been noticed in the tailings from quartz mills, being the remains of stones which had been broken under the stamps. In one locality they were found in the gray cemented gravel underlying a stratum of so-called lava or compact ash; but usually the gravel was mixed with lava, ashes or other volcanic matter, which gives a hint of the source of the stones. The paper of Mr. Kunz gives the first official notice of the finding of a diamond eight years before (in 1876), at Eagle, Waukesha county, Wisconsin, it having been thrown out with a bucket of gravel by a well-digger from a depth of 60 feet. This was the first Wisconsin diamond, and it weighed 15 carats, but was slightly off color. "Having carefully examined a quantity of the gravel sent to different persons," Mr. Kunz wrote, "I have failed to find anything but the regular debris from glacial drift." One of the best methods of prospecting a new district for diamonds, in his judgment, is to familiarize the searchers with the lustre of real stones, for which purpose small imperfect crystals sold at $5 to $10 will suffice. "Several thousand searchers thus prepared would soon ascertain whether diamonds really existed, and the crystal would also serve for testing the hardness of the stone as well as the lustre."

Prof. Hobbs has given a careful account of discoveries of diamonds in glacial drift since the finding in 1876 of the stone of 15 carats at Eagle, Wisconsin, mentioned by Mr. Kunz, to the finding of one weighing 6 carats of purest water at Milford, Ohio, in 1897. A tenant farmer's wife kept the Eagle stone seven years as a curious thing, and without faith in the old-word "keep a thing seven years and turn it over," she sold it to a Milwaukee man in the jewelry business for one dollar. The jeweler submitted it to an expert, and was told that it was a diamond. Then the woman offered to repurchase it for $1.10, and being met with a refusal, she brought suit to recover its full value. The case was finally carried to the Supreme Court of the State, where a decision was given in favor of the jeweler on the ground that he, no less than the woman in whose well it had been found, and who had kept it as a curious thing seven years, had been ignorant of the value of the gem when he bought for a dollar. That stone has been purchased by Tiffany & Co. of New York, and is still uncut in the Tiffany collection. Another of the interesting incidents in the story of the Eagle stone is, that the discovery of it led to the booming of the property for diamond mines. In 1886 another stone was found by a farmer of Kohlsville, Wisconsin, while ploughing in his field, and it is still owned by his widow. The weight is 21¼ carats. In the years 1887, 1888 and 1889 the gravel bed of Plum creek in Wisconsin was prospected for gold, and ten or more diamonds were found weighing from ½ carat to 2 carats each, besides a number of microscopic size. They were associated in the water-worn gravel with garnets, gold and platinum. Some were colorless, some bluish and others yellowish. Late in 1893 a white diamond weighing nearly 4 carats was brought to Prof. Hobbs by a farmer of Oregon, 12 miles south of Madison. The farmer's little son had found it while playing in a clay bank. It was this discovery that awakened the Professor's interest in the subject of diamonds, and to it we are indebted for a number of valuable papers from his pen. Another diamond, reported to

have been found at Burlington, Wisconsin, came into notice in 1893, but no particulars of it have been learned. In 1894 a stone weighing almost 11 carats was found in the glacial drift at Dowagiac, Michigan, on the Michigan Central Railway, between Niles and Kalamazoo. The next reported find was in 1896, by a German farmer at Saukville, Wisconsin, but it had been in his possession 15 or 16 years. It was a white diamond of 6½ carats. The latest discovery mentioned by Prof. Hobbs was the one at the town of Milford, near Cincinnati. "No less than seventeen identified diamonds," he writes in the Journal of Geology, "varying in weight from ½ carat to 2 carats, have been discovered in the region of the Great Lakes of North America. That a considerable number of others have been found, which have not been reported because they have escaped identification, hardly admits of reasonable doubt when it is borne in mind that three of the stones found (including the two of largest size) remained in the hands of the farming population without their nature being discovered for periods of eight and one half, seven, and over fifteen years respectively. If it were possible to visit all the houses in the lake region," the Professor goes on to say, "I have no doubt that many diamonds would be discovered in the little collections of pebbles and local curios which accumulate on the shelves of country farm houses" We have all seen these little collections of "lucky stones," as they are often called—or at least all of us who have visited at or lived in country homes—and to help in distinguishing diamonds from other stones (for we in Ontario are also in a morainic region) the following extract from Prof. Hobbs' paper in Appleton's Monthly may prove useful:

"Diamonds never appear in thoroughly rounded forms like ordinary pebbles, for they are too hard to be in the least degree worn by contact with their neighbors in the gravel bed. Diamonds always show, moreover, distinct forms of crystals. They are never in the least degree like crystals of quarts, which are, however, the ones most frequently confounded with them. Most of the Wisconsin diamonds have either twelve or forty-eight faces. Crystals of most minerals are bounded by plane surfaces—that is to say, their faces are flat—the diamond, however, is enclosed by distinctly curving surfaces. The one property of the diamond, however, which makes it easy of determination is its extraordinary hardness—greater than that of any other mineral. Put in simple language, the hardness of a substance may be described as its power to scratch other substances when drawn across them under pressure. To compare the hardness of two substances, we should draw a sharp point of one across a surface of the other under a pressure of the fingers, and note whether a permanent scratch is left. The harder substances will always scratch the softer, and if both have the same hardness they may be made to mutually scratch each other. Since diamond, sapphire and ruby are the only minerals which are harder than emery, they are the only ones which when drawn across a rough emery surface, will not receive a scratch. Any stone which will not take a scratch from emery is a gem stone, and of sufficient interest to be referred to a competent mineralogist."

All of the diamonds described in Prof. Hobbs' papers were obtained from deposits of glacial drift, except those found in the bed of Plum creek, which is in the near vicinity of glacial deposits. The localities of the discoveries are distributed over an area of 600 miles in length by 200 in breadth, and six or eight of them lie within an area of 200 miles square, with its centre near Milwaukee. Another important point is, that nearly all the localities are upon or near to kettle moraines. But before going on to deal with the probable source of the diamonds of these moraines, the question of origin will be considered.

ORIGIN OF DIAMONDS.

In the view of Dana and other authorities, the diamond has probably proceeded like mineral coal and oil from the slow decomposition of vegetable material, or from animal matters which afford the requisite carbon. But it must have been formed under like conditions of heat as those which produced the metamorphism of argillaceous and arenaceous shales, and their auriferous quartz veins, as it is found exclusively in gold regions or in the sands derived from gold-bearing rocks. The schists that were altered at the time may have previously been shales impregnated with petroleum, bitumen or other carbonaceous substances. In the humid oxydations of carburetted hydrogen, Dana says, the hydrogen is oxydized, part of the carbon becomes carbonic acid, and the rest remains

as carbon and may form crystallized diamond, just as sulphur is formed from hydrosulphuretted emanations. It has be observed, however, that the diamond crystal often contains microscopic cavities so numerous in some stones as to render them nearly black, and under polarized light it shows evidence of compression, "as if from pressure in the included gas when the diamond was crystallized." In Brazil and the Urals the stone generally occurs in regions having a laminated, granular, friable quartz rock called itacolumite, while in South Africa it is found in place in a matrix commonly known as blue ground.

DIAMONDS IN SOUTH AFRICA.

The first diamond workings in South Africa were commenced about a third of a century ago, in the gravel beds of the Orange and Vaal rivers, and in 1870 the dry diggings where the town of Kimberly now stands were discovered. Within a radius of 3½ miles four mines began to be worked under conditions unlike those of any other known locality. What were at first supposed to be alluvial deposits were shown by the workings to be the vents or pipes of extinct volcanoes. The smallest of the four, known as De Beers mine, has a surface area of 22 acres, while the largest, known as Du Toits Pan, has an area of 45 acres. Operations were at first carried on by excavations of the diamond-bearing material, which for some distance from the surface was a soft yellowish earth that crumbled readily when exposed. At 100 feet it became darker and harder, acquiring a slate blue or dark green color, and resembled some varieties of serpentine. It is greasy to the touch, like serpentine, and is full of fragments of slate and other rocks. When exposed to the sun for some time it is readily crushed, and the diamonds are extracted by washing. In the De Beers mine two years ago the lowest workings had reached a depth of 1,500 feet, the method of mining adopted being to sink a shaft through the country rock and drive levels into the vent for stoping. In this way facilities have been afforded for a study of the geology of the Kimberley mines, but the scientists have not yet reached a stage of agreement upon all points. The shales which form the country rock underlie the district for many miles in every direction from the mines. In the opinion of some authorities the carbon for the diamond was supplied by these shales. The material of the neck, according to Prof Carvill Lewis, is a dark-green heavy rock resembling a dense serpentine, in which one sees glistening plates of brown biotite, small deep-red garnets, large dark-green crystals or grains of olivine and bronzite, and a large number of angular fragments of altered black shale, so abundant as to give the rock a brecciated appearance. Olivine, he says, forms the most abundant constituent in the rock, placing it among the peridotites. There is also a large proportion of calcite, and among other constituents are pyroxene minerals, titanic iron, mica, apatite, talc, chalcedony, garnets and zeolites. In his second paper on the subject, read at the meeting of the British Association in 1887, Prof. Lewis said that explorations of the preceding few years had placed it beyond question that the serpentine rock called "blue ground" was in reality the matrix of the diamond. "Recent investigations," he wrote, "seem to place it beyond question that diamonds are as much a part of the Kimberly rocks as biotite, garnet, titanic and chromic iron and perovskite, and that, like these minerals, they may be considered as a rock ingredient. The fact that they continue just as abundant, if not more so, the deeper the mines are explored; that they are never found in, or especially associated with, the foreign inclusions of gneiss, granite or sandstone; that they are distributed abundantly through all parts of the rock; and that in each of the four principal mines the diamonds have distinctive features of color, lustre and shape, are, with the microscopical evidence of the eruptive character of the rock, strong reasons for holding that the diamonds now lie in their original matrix."[1]

On the other hand Prof. Bonney, the Geologist of University College, London, and himself the editor of Prof. Lewis' papers, affirms in a paper read before the Royal Society last year that the blue ground is not the birthplace of the diamond, any more than of the olivine, garnets, pyroxenes and other minerals which it incorporates. A study of

[1] Papers and Notes on the Genesis and Matrix of the Diamond by the late Henry Carvill Lewis of Philadelphia, edited from his unpublished MSS. by Prof. T. G. Bonney, p. 44.

specimens of eclogite from the Newlands mines[2] has convinced him that the diamond is as much a constituent of that rock as zircon may be of granite or syenite. His position is that neither the diamond was formed by the action of molton rock on carbonaceous material, nor produced in place by the action of steam or hot water in a subsequent solfataric stage of the volcano, but that it was formed like the garnets and pyroxenes "in some deep-seated holocrystalline mass which had not been scattered by explosions." The constituents of the blue ground, Prof. Bonney says, are chiefly waterworn pebbles of crystalline and sedimentary rocks, and probably have been supplied from the conglomerate, which underlies the Kimberley or Karoo shales, and is supposed to be of Permian or Permio-carboniferous age. "If this deposit has supplied the boulders, the date of the genesis of the diamond is carried back at the very least to Palæozoic ages, and possibly to a still earlier era in the earth's history." This is as far as the English professor goes. He does not suggest that the diamond was always diamond, nor that it is anything else than pure crystalized carbon. And he does not gainsay the utility of volcanic force as an agency in the distribution of diamonds, even if, through the dynamics of heat and pressure, it had no lot or part in their genesis. It was the Kimberly volcanoes, or others like them, which brought to the earth's surface the diamonds first discovered in South Africa, in the lower valleys of the Vaal and Orange rivers.

Scientific theories are full of interest, especially when they are founded upon observed facts ; but although diamonds are said to have been produced in the laboratories of two or three men, no eye has witnessed the operation of the process in the alembics of Nature. We can gather and collate data, however, and in the clear light of facts and conditions we may reason our way to sane, if not to positive conclusions. And having, as I think, built up a good working hypothesis, I come back to the question,

ARE THERE DIAMONDS IN ONTARIO?

It has been conclusively shown that there are diamonds in the glacial drift of Wisconsin, Michigan and Ohio, for they have been found there. It has been conclusively established, also, that during the ice age the materials of the drift were borne down into those States from the highlands of Ontario, for many of the stones, pebbles and gravels, constituting the drift are identical in composition and structure with varieties of ice-planed country rock which abound in regions northward of the Great Lakes. From Ungava territory east of Hudson bay and Keewatin territory west of it two great mantles of ice, moving south and southwest, shoved before them and carried with them all the disintegrated rocks, clays, sands, gravels and boulders of every size. Whatever was loose on the face of the earth, those ice sheets gathered up in their huge folds, to be broken and crushed and pulverized, and to be dumped off as one would unload a cart, scores or maybe hundreds of miles from the parent rock. The terminal moraine which marks the southerly limit of the ice field has been clearly traced across the States of New York, New Jersey, Pennsylvania, Ohio, Indiana and Wisconsin ; but there are many moraines of recession whose positions are not so well known. One of the most important of these lies almost at our own door, known as the Oak Ridges in some sections of it, and in others as the Pine Ridges. It extends across the counties of York, Ontario, Durham and Northumberland, but our geologists have hardly looked at it yet. Mention is made of it here merely to point out that it is very largely composed of materials derived from the rocks nearest to it—from the Hudson River, Utica, Trenton and Black River formations. There are, of course, many fragments of crystalline rocks from the older formations, but as far as I have observed the great body of the moraine has been built up with the debris of local rocks. The moranic ridges around Rochester, in New York State, are composed largely of material from the Medina sandstones and

[2] At these mines in West Griqualand the workmen occassionally come across well rounded and boulder-like masses, some of which are a foot in diameter, of crystalline rock studded with garnets, and the specimens studied by Prof. Bonney were from these mines. One of them which contained a number of imbedded diamonds is described as a coarse grained rock, apparently composed of two green-colored minerals, one darker than the other (but possibly only different states of the same mineral) and of rich resin-pink colored garnets, varying in size from a hemp seed to a pea, with slightly irregular distribution. Putting aside the diamonds, the rock in its unaltered condition is a crystalline mixture of chrome-diopside and garnet, with a few small enclosures of olivine, being a variety of eclogite and of igneous origin. "Take away the alkali from a magma with the chemical composition of a diorite, and the result would be garnets n place of felspar, *i.e.* an eclogite."

shales; and the terminal moraine in Pennsylvania consists chiefly of rock and earth, carried down from formations which outcrop either in the northern counties of that State or from southern and central New York. There are, of course, many boulders and pebbles of Archæan formations, and I do not doubt that a good percentage are of Canadian origin. I have noticed, indeed, that when an American geologist comes upon a boulder of granite, or gneiss, or quartzite, he calls it a "Canadian." The fact is obvious, however, that glacial drift is not in the mass borne very long distances; and it would require good evidence to sustain the opinion of Prof. Hobbs that the moraines of Ohio, Michigan and Wisconsin in which diamonds have been found are constructed out of materials carried upon ice or shoved forward by it a distance of 700 miles from the tableland of Ungava[3]

We have not been looking for diamonds in Ontario, although Dr. Lawson and Dr. Coleman some time ago suggested the probability that they might be found in the Rainy Lake region. In his report on the geology of that region Dr. Lawson wrote: "The occurrence of bosses of serpentine suggests the possibility of diamonds, and some enterprising prospector may yet be rewarded for a close examination of the vicinity of the serpentine rocks indicated on the map, or of others that may be discovered, particularly if they be found near the carbonaceous schists that sometimes occur in the Keewatin.[4]

In these Keewatin rocks Dr. Lawson found evidence at several points of extinct volcanoes, one or two of which were of immense size. Dr. Coleman alluded to the matter in the Fourth Report of the Bureau of Mines, and in the Seventh Report he referred to the widespread occurrence of slates in the Keewatin, some of which have a graphitic look. He mentions one sample analyzed by Dr. Adams which gave 7.44 per cent. of carbon. But it will be said that these localities are too far west to supply drift material even for Wisconsin, as the direction of ice movement there was southwest. A locality in which conditions equally favorable are presented is the north shore of lake Superior, around Thunder cape, where there is a thickness of not less than 1,000 feet of Animikie slate, cut through by numerous dikes of diorite, with intrusive sheets of the same material which Lawson has shown to be laccolite sills. Logan counted thirteen of these dikes parallel to each other in a width of two miles, one of which has a thickness of 200 feet, and referring to the chert layers at Thunder bay in the report for 1846-7 he wrote: "Some of the chert bands appear to be made up of a multitude of minute, irregular, closely aggregated sub-globular forms, floating as it were in the siliceous matrix, and anthracite appears to be present in some of these, leading to the supposition that the color of the black chert, even where the sub-globular forms are not detected, may be owing to the presence of carbon." Another interesting fact is mentioned by Macfarlane, who found plumbago with copper, iron and magnetic pyrites on Pyritic island, and that frequently large patches of the veinstone of Silver Islet were impregnated with graphite.[5]

In conditions like these, where carbonaceous slates have been subjected to the influence of molten rock in the forms of dikes and sills under great pressure, I think we ought to look for diamonds and expect to find them. The likelihood is not less in a large dike than in a volcano neck, if one of the theories on the origin of diamonds is true; and we have been treated to too many surprises by new discoveries within the last ten years in Ontario to be deterred or dismayed by the man who says a diamond has never yet been found in a dike or a sill in a formation of carbonaceous slate. But there are numerous other localities in northern Ontario besides the region of Thunder Cape, where in like circumstances diamonds might possibly occur. I mention only one, the township of Balfour near Sudbury, where a vein of anthracitic carbon was discovered four years ago in a formation of fissile slate. Analyses made by Dr. Ellis showed the vein matter to give 7.42 per cent. of fixed carbon and the slate 6.8 per cent. Samples of slate from the same region recently analysed gave as high as 13 per cent. of carbon.

[3] Owing to their extreme hardness diamonds would be affected in very slight degree by wear and tear of glacial action; but as the ice was constantly losing part of its load, especially upon the southern slope of ranges of rocks, it is hardly conceivable that stones the size of diamonds would be carried the long distance of 700 miles.

[4] Report on the Geology of the Rainy Lake Region, by Andrew C. Lawson, p. 180 F. Geo. Sur. Report, 1887.

[5] The Canadian Naturalist, vol. iv, New Series, pp. 461-463.

NIVEN'S BASE LINE, 1899

By William A. Parks

The 120th mile post of the Nipissing-Algoma boundary is situated some distance north of the height of land, in the vicinity of Night Hawk lake. In the summer of 1899, Alexander Niven, O. L. S, was despatched under the authority of the Commissioner of Crown Lands to run a base line from this point due west, a distance of about 120 miles, to Missanabie lake. Under instructions from Archibald Blue, Director of the Bureau of Mines, I accompanied this survey to report on the geological and topographical features of the region, as well as its soil, timber, water powers, drainage and various minor features. By taking advantage of the numerous water courses, crossing the country north and south, a considerable area was explored, and by following the Indian canoe routes between the rivers valuable geographical knowledge was obtained. In view of the very incorrect maps now existing, a more accurate description of these cross routes should prove of great value.

Accompanied by Mr. H. S. Michie of Fergus, who acted as my assistant during the summer, the party arrived at Matagama Station on the C. P. R, early in the morning of the 6th day of June. From this point we proceeded by an excellent canoe route to Fort Mattagami, and thence to our starting point, the 120th mile post on the Nipissing-Algoma boundary. A description of the territory traversed by this route will form the first division of the report proper.

The line ended a short distance west of Missanabie lake, and I was able to report in Toronto on Sept. 21. On the map accompanying this description I am able to vouch for the accuracy of the plans described in the text; some other routes are shown, which I believe to be substantially correct, but which I have not been able to verify by personal observation.

ROUTE TO FORT MATTAGAMI.

The canoe route leaves the railway a short distance east of Mattagama station, on the south side of the track. It is represented by a small creek, about ten feet wide, flowing approximately parallel to the railway, in a northwest direction, and expanding in places into shallow marshes. This stream crosses to the north of the line, about a mile west of Mattagama, and passes into the Spanish river. At this point are seen Laurentian outcrops, represented by pink and gray granites with included fragments, the whole fading imperceptibly into gneiss. One half mile up the Spanish river is a small rapid over gneiss, with a short portage on the easterly side. A mile above is a small rapid, requiring no portage. On proceeding a short distance above this point a lake-like expansion is seen, with a waterfall visible straight ahead. The route, however, does not follow the river in this direction, which leads to Biscotasing, but turns off to the right, and at a distance of three or four miles down stream arrives at a gorge in pink granite, passed by a short porttage on the east side. Twenty chains lower occurs a heavy fall, with a somewhat longer portage on the right hand side. Below the portage we cross the river, and keeping the left shore again start up stream. This alternation of up and down stream is at first very confusing, and almost inexplicable. It is owing to the existence of a large island in the Spanish river, and to the fact that this stream is composed of two branches.

On both sides of the river below the last mentioned portage an interesting series of Laurentian rocks is exposed. First is seen a highly hornblendic granite with numerous veins and concretions, followed by undoubted gneiss which is capped by a fine pink eruptive, almost destitute of any ferro magnesian constituent. A similar eruptive occurs on the left side of the river, rising into hills of some height; it is much mixed with gneiss, and shows many varieties, varying from a binary granite to a coarse highly hornblendic example of the same rock.

From Mattagami to this point the usual timber of this northern country has been in evidence; chiefly spruce, poplar, birch and tamarac. Here however, and for some distance to the north, areas of pine occur, and large stretches indicate having once been covered with that timber, though now presenting only scrub and fire-swept forests.

After turning to the left around the point below the last portage, we ascend a river-like stretch with a couple of rapids, after which for 25 miles we follow a series of narrow lakes, in a direction almost due north. The upper Spanish river pine area may be said to more or less continuously surround these lakes. Some timber has been cut on these ranges, but I am told that the venture did not prove a financial success. As far as I was able to observe, both here and at other points in the region, the timber is undersize, a two-foot tree being the maximum, with the average considerably lower.

The rock throughout this stretch is gneiss, in places very granitic; the scenery on the whole is bold, hills of 100 to 200 feet being frequently visible from the water. The soil is scanty and mostly represented by sand. From the last of this series of lakes the route follows a small and very swift creek for about two miles to a lake of a mile in length, also due north. Here we cross a 10 chain portage 20° w. of n. to a little lake of beautifully clear water, indicating our proximity to the height of land. The rock on both creek and lake is chiefly gneiss, but exposures of porphyritic granite are seen, as well as a dike of diorite, 100 yards wide, striking E. and W., and crossing the creek valley near its upper end.

The last mentioned lake as well as the one below it ushers us into an area of burnt sandy territory, which continues, with some interruptions, a long distance to the north and west. A little to the left of the end of the last portage on the small clear-water lake, another canoe route connects with this one; this route leads to Biscotasing, and is generally used by Indians travelling light; but, as it necessitates some long portages, it is not suitable for heavy freighting. After crossing this lake, we make another 20-chain portage into a lake about a mile long, from the extreme northern end of which a portage two miles in length, 30° E. of N., brings us to Kapismapenaceke lake. This portage traverses coarse sand and gravel, all burnt, but young pitch pine bid fair to again clothe the region in green.

Some exposures of gray and pink porphyritic gneiss are seen on this portage; the average strike points to a general east and west arrangement of the rocks. In the vicinity of Kapismapenaceke lake, outcrops of rock are not frequent, the surface consisting exclusively of coarse sand and gravel, from which the old forest has been entirely removed by fire; some few red pine on the islands point to the previous condition of the country. From the northern end of this lake a route leads to Mesumekenda lake and thence to Kenogaming. The trail to Mattagami turns off to the right as shown on the map, and descends a small creek with some rapids to Muskegogama lake (Swampy lake).

Just before entering the lake a belt of rocks is encountered, striking N. 30° W., and presenting examples of diorite and diorite schists.

Muskegogama lake is in all about five miles long, and is for the most part surrounded by green bush. The river out bears the same name, and is interrupted a short distance down by a fairly heavy rapid, making necessary a short portage (3 chains) on the right hand side. The rock here is diorite. Twenty chains more of river brings us to another rapids and a ten-chain portage, also on the easterly side. The rock here may be either granite or gneiss, and is crossed N.E. and S.W. by veins of a fine grained eruptive, probably diabase. From here to the next portage is about two miles, the lower part of which is swampy, while the upper part shows granite and gneiss crossed by numerous dikes of diorite. This portage is made to avoid a long series of rapids, and is about one and three-quarters of a mile in length, over sandy soil well covered with small timber, pitch pine predominating. This trail enters at the southern end of Minniesinaqua lake (Wooded Islands). We follow this lake for 25 or 30 miles, making a turn at right angles about half way down. It has green shores for the most part, but only an occasional pine. On entering the lake we encounter a dark green massive diorite, which soon gives place to various Huronian schists, which alternate with granites and other rocks, all much contorted and altered. True pink gneiss occurs at the point where the lake turns to the east, and although gneiss occurs in places on the south arm, Huronian schists and diorites, together with more or less crushed granites and felsites, form the main country rocks. A short description of these rocks follows:—

Diorites: Dark and light green, the latter entirely altered under the microscope, showing little but kaolin and a fibrous indistinct derivative of hornblende.

Schists: Light gray and olive colored rather hard examples, showing little but fine quartz under the instrument. Also a dark green white spotted variety.

Granites: Pink and red, more or less crushed, showing strained quartz, altered orthoclase, and with the original mica converted into magnetite and indistinct products.

Felsites: Fine grained, and weathering quite white.

Passing down the Minniesinaqua river we run a small rapid, and two miles below another. Just beyond this we make a 60 ch. portage on the east side, over gneiss and sand (Fishing rapid portage). Below the portage is some rough water to run, and almost immediately we enter the Mattagami river, or, as it called by the Indians, Nā pow-qua-zi river.

From the junction of the two streams to Fort Mattagami is about five miles, the latter half of which is lake. Green shores are continuous, and the soil deep, only a few exposures of gneiss being seen. The post is beautifully situated on the point dividing the two southern arms of the lake. This is an old and important location of the Hudson's Bay Co., and although the present buildings are comparatively new the post has been in existence for 200 years.

To the east of the post a long bay of 10 miles stretches almost due south. Its shores for the most part are rocky and well timbered, but no pine is seen. The northern end presents exposures of gneiss and bands of mica schist and felsite, while to the south a more granitic aspect is apparent in the rocks. Towards the extreme south end the granite becomes very coarse and porphyritic, and is followed on the easterly side by gray and green spotted micaceous schists; also sericitic chists mixed with granite and felsite. Below these exposures are bands of intensely crushed and sheared granites, followed by a high hill presenting Huronian schists and a pronounced volcanic conglomerate, with bombs of granite varying from two feet in diameter to microscopic dimensions. All these rocks strike nearly east and west. From the peak of the bay a mile and a half portage over a sandy and hilly country brings us to a small lake of clear water, forming the first step on the route to Nā pow-qua zi lake and river. On the east side of the bay, about half way from the post, a stream enters in a narrow inlet. This is the head of an old canoe route to Matachewan, and thence to Temiscaming; owing to extensive windfalls in the spring of 1899 this route has been rendered practically impassable. Indians now making the journey go by the Gull lake, or winter road.

The northern branch of Mattagami lake is about 20 miles long, and seldom exceeds a half mile in width, while the average is even less than that. Many high rocky hills approach the shore line; these bluffs are composed of granite or gneiss, perhaps both, insensibly merging into each other. No other rocks were seen on the stretch.

Kenogamissee portage, of a half mile on the west side, connects this lake with Kenogamissee lake (Long lake), which stretches 25 miles to the north and is in nearly all respects similar to Mattagami lake. The rocks, however, show a little more variety. At the portage the water rushes over a bed of gneiss, but a dike of diorite runs along the west shore; another such dike infringes on the lake, about six miles down, and is perhaps accountable for the narrows at that point. Six miles below this we find crushed granite and mica and hornblende schists, with fine pink granite and felsite. These rocks are followed to the north by soft Huronian mica schists striking E. 10° N., and dipping 30° from the vertical to the northwest This narrow belt is not continuous, but gives place to the usual granitic gneiss, which however is occasionally interrupted by intrusive granites and greenstones to the foot of the lake.

The Mattagami river breaks out of the foot of Kenogamissee lake through a gorge in which the water is extremely rough, rendering necessary a mile portage on the east side. On this trail are seen soft schists with quartz, striking N.W. and S.E., and dipping almost vertically. Below the portage the traveller is advised to cross immediately to the west side, and run fairly close to that shore into the bay below. In this bay a strong eddy runs up the east side, whence the name of the rapids and portage, Wawiatan (Eddy).

On the shores of both these long lakes some few pines, both red and white, were noted, where the country had not been burned, but I doubt if the size of the timber or its abundance would ever warrant a camp for its removal.

Pine may be said to be practically absent from the country north of the Wawiatan portage. For seven or eight miles the river proceeds with rather a stiff current to the Omeemee (Pigeon) rapids. Here a portage is required only in very low water; in high water nothing but a strong current is observed. On this stretch we pass the mouths of two considerable streams, the Grassy river on the right and almost opposite the Ta-ta-

ti-chap-i-ka. The shores of the Grassy show continuous sands hills as far as observed. The current is very swift, and but few portages are required to reach Peter Long's lake. The lower four or five miles of the Tatatichapika river are almost continuous rapids; to avoid these a portage above the Wawiatan rapids connects the river with Kenogamissee lake. This portage forms the head of a route to Kenogaming and the Ground Hog river. For the plan of this route as shown on the map I am indebted to Mr. Jos. Moore of Fort Mattagami. This river drains Great Pike, Misquamabie (Red Sucker) and Tatatichapika lakes. Owing to a thick covering of sand exposures of rock are not frequent on the river; where seen, however, they indicate a continuous Huronian area. At the Pigeon rapids hard schists of a light olive green color are mixed with some softer kinds, containing quartz, an assay of which resulted in a strong trace of gold, possibly two dollars per ton.

The line at 16 m. 20 ch. crosses the Mattagami four or five miles below [illegible] mee rapids. Some distance above the line at a point where the river curves to the west, a portage leads into Water-hen lake. This trail ascends a river bank of some height, and then follows a level sandy country with small pitch pine to the lake. Around and beyond this lake the country is low and somewhat swampy. The line passes close to the northern end of the lake, and at about this point leaves the larger spruce and poplar timber, and enters an area of tamarack and spruce scrub. Expeditions in various directions revealed an essentially similar country, with burnt areas and windfall for some distance.

From the line to Southeast Bend brook is three or four miles. Just below this stream is the head of the first portage to Night Hawk lake, which will be described later. Below this point the river continues north for four miles, and then turns sharp to the west for about five miles, bringing us to a series of heavy rapids. The traveller should keep the west shore and run into a creek entering just above the rapids; here a 15 ch. portage enables him to pass. A small island breaks this rapid, and it may be run to the left of the island in light canoes. A mile of swift water brings us to the second portage, also on the west side and about 15 ch. long. Care is required below this portage, as there is some bad water to run near the west shore. It is advisable to keep well out on nearing the end of an island seen in the river, and then cross to the east side below it; here will be found the third and last portage, the sandy portage proper, known to the Indians as Kiskequāmo. The series of rocks presented at these rapids is as follows: Hard gray schists at first portage. Below, a coarse gray, somewhat schistose rock, composed of quartz, felspar and pearly mica, apparently an altered quartz diorite or porphyrite. At the top of the second portage: Hard schists and some softer varieties with streaks of quartz, all striking N. 60° W. At the foot of the portage a dike of massive green diorite strikes N. 20° W.

At the last portage we find fine grained gray quartz schists, with some pyrite and streaks of quartz; an assay from here gave traces of gold.

On all three portages the soil is sand, but below we commence to encounter the clay belt. Some small clay areas have already been seen, but clay now begins for the first time to constitute the main soil. It is interrupted by some sand at various places as far as the Kamiskotaia Sagaigan river, where it seems to become continuous. Below this stream the Mattagami is about four chains wide, with gentle current for ten or twelve miles, beyond which it was not explored. The shores here are continuously low, and show clay soil with poplar, birch and spruce, and only occasional exposures of Huronian schists and massive diorites.

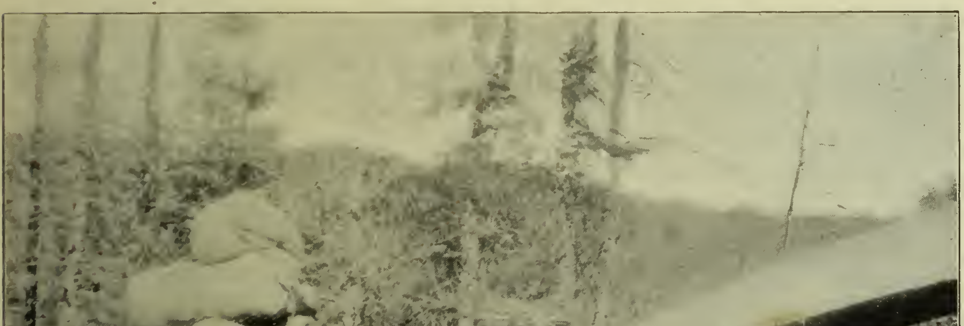
ROUTE TO KAMISKOTAIA LAKE.

The Kamiskotaia river enters the Mattagami on the west side, about six miles below the three sandy portages. It is about 40 ft. wide at its mouth, but its navigability is interrupted by rapids. Only a short distance up we portage on the south side, and just beyond are forced to carry on the north side to avoid a heavy fall. A half mile above this fall is another rapid; just below it we enter a creek on the south side, and make a 60 ch. portage to another stream, also a tributary of this river. On this portage occurs a peculiar hard schistose rock, striking a little south of east. It presents various shades of pink and green, and weathers out with white dots, owing to a decomposed felspar

44. Indian Children at Fort Mattagami, p. 125.

45. Three Generations at Fort Mattagami, p. 125

46. Canoeing near Height of Land in Algoma District.



47. Packing Supplies in Northern Algoma

Microscopically it shows a very fine grained structure, and consists principally of quartz and a fine turbid decomposed ingredient. This rock runs up into a hill of considerable height, from the summit of which several such conical hills are visible, particularly to the north and west, giving a characteristic appearance to this region. From the end of this portage, we ascend the creek through a low and swampy country for about a mile and a half, and make a portage about north to a second stream which flows out of Kamiskotaia lake. On this stream are seen massive green diorites and fine grained gray and green schists, the latter probably altered diorites

Kamiskotaia lake is a fine body of water of from two to three miles in diameter, and containing several rocky islands. The rock at the head of the river is a hard massive green to black rock, resembling diorite, but it contains a large amount of quartz. Under the microscope it shows decomposed plagioclase crystals and blebs of quartz, all imbedded in a fine grained matrix, consisting largely of quartz with minute grains of a dark alteration product. It is probably an altered quartz diorite.

ROUTE TO NIGHT HAWK LAKE.

The first portage to Night Hawk lake leaves the Mattagami river, as above indicated near the Southeast Bend brook ; it runs due east about one and three-quarter miles. After ascending a slight elevation, the trail leads through a rather wet country, well timbered with good sized spruce and poplar. For about a mile it then mounts a little higher, and continues for the rest of its length over dry sandy soil, with pitch pine. A very small lake succeeds, and then a short portage north to a larger lake about one and a half miles in length. This lake presents some bold bluffs on the easterly side, mostly diorites, with cubes of pyrite and streaks of quartz, but on the westerly shore fine gray schists with pyrite and soft whitish examples, all striking N.E. and S.W. The route does not lead through the lake, but follows the east shore around a point and a small island to the next portage of 20 ch. S.E. The next lake is shallow, and rock outcrops occur only at the eastern end near the portage, which is one and three-quarter miles long, about east and very rough. Fairly heavy timber occurs here, poplar and spruce and some cedar of good size.

From west to east the following series of rocks is presented : A soft schist, weathering rusty, fine and resembling quartzite across the planes, but pearly on the partings.

A green and purple schist, the matrix so fine grained as to resist any resolution into constituents, spotted with white porphyritic dots of decomposed felspar. Light green altered diorite and diorite schists. Soft and rusty schists, as at western end. Quartz occurs at various places, an assay showed decided traces of gold.

The portage ends on a small and crooked creek, crossed by several old beaver dams. We descend this stream a mile and a half, and make a two miles portage into Porcupine lake. Some rock occurs on this trail, and it is worthy of note that we here enter the clay area of Night Hawk lake.

Porcupine lake has already been described in the Report of the Bureau of Mines for 1898. Access to Night Hawk lake may be effected either by the two portages indicated or by the river, which is easily navigable, only one short portage being required to pass a permanent log jam.

The line, starting from the 120th post on the boundary, continues for only a short distance in the clay area of Night Hawk lake. It then enters a rough hilly and rocky country.

This region of Huronian outcrop is first met at two and a quarter miles, and continues with some interruptions to about the sixth mile post. Although a little clay was seen, fine white sand is the prevailing soil west of the rough country.

Several expeditions were made through this region, and an interesting series of rocks discovered.

The more southerly aspect of the ridge consists of a fine grained, somewhat crushed, granite, bounded on the north by sericitic schists, striking N. 10° E. This is followed by a peculiar streaked, fine grained quartzite rock for ten chains. This rock is well mineralized, and several assays showed varying traces of gold.

To the north of this is more of the soft sericitic schists, followed by hard gray schists. This series is repeated in practically the same order by a second ridge north of the former one.

Two miles farther west a cross-cut of this country showed at the north a soft weathering sericitic schist, followed by massive diorite. Beyond this occurs a felspathic schist, with pearly mica, containing streaks of quartzite and weathering very ferruginous. This is followed by alternating bands of quartz and quartzite, yielding as high as one dollar per ton of gold on assay.

Sixty chains from the lake a second ridge of pink quartzite is seen to contain bands of true quartz. Towards its south flank this belt becomes very ferruginous, with crystals of both hematite and magnetite.

The last rock seen was a succession of soft and hard schists, all striking east and west and dipping north at a high angle.

This region is certainly worth thorough prospecting.

On the south bay of Night Hawk lake only a few exposures of Huronian schists and diorites are visible. Passing south in the vicinity of the old boundary line, on Starvation creek, heavy clay soil and luxuriant vegetation were encountered. This creek is said to form part of a route to the Grassy river, passing close to Mt. Sinclair. Owing to almost continuous jams of driftwood it was found impossible to navigate the stream, and the attempt to explore the Grassy river had to be abandoned.

There are several canoe routes between the Mattagami and Ground Hog rivers. One by way of Opishingquaquaya and Wawayeshatching lakes is shown on the map. This was sketched from information obtained at Fort Mattagami. The best used road, however, is that about to be described. It starts in the southwest angle of Minniesinaqua lake, from which point a choice of two routes is offered for a short distance. Close to the high rocks a small creek enters the lake, which may be ascended to a little pond, above which two half mile portages bring us to Windegoaquinzing (Cannibal) lake, which discharges at its northern end into the same river, which enters Minniesinaqua lake close to the north of the creek.

This stream is about a chain wide, and varies much in depth. On the whole, the current is swift and the water clear. The country consists entirely of sand, as shown by the sand and shingle in the river bed. The timber shows some fair sized spruce and a few red pine, while poplar and birch are common as elsewhere.

Three portages are necessary, one about a mile up past a log jam, and two others at the upper end, near Windegoaquinzing lake. From this point the stream holds in a west and southwest direction for about three miles to Macaming (Sore) lake. The only rocks seen on the river were granite and gneiss of Laurentian age, and the same rocks crop out on Macaming lake, rising into high hills at the southern extremity of the lake. The route lies straight through the lake in a southwest direction for over three miles. The river enters at the end over a ridge of gneiss six or seven feet high. There is a portage of ten chains on the easterly side. Twenty chains above is another rapid, and a short portage on the westerly side over granite. Considerable pitch pine occurs here, and continues to Mesumekenda or Great Beaver lake. On this lake, which is of considerable size, outcrops of granite and gneiss are common. The green bush, almost continuous from Minniesinaqua lake, here begins to give place to an extensive burnt tract.

Through this lake lies the route to Kenogaming, as already indicated. The portages as shown on the map are about correct in sequence, but it is very likely that their position is incorrect as well as the outline and bearing of the lakes. This chain of lakes is copied from old maps, with some corrections. From information obtained from Indians, these lakes are very much larger than indicated, and therefore the route must be much more crooked in order to allow larger lakes in the same distance. A reliable man gives the route from Mesumekenda to Kenogaming thus:

Creek—lake, five miles—creek—lake, six miles, Ka-na-ma-co-sen ce-ha—two short portages—lake, twelve miles, Ka sas-way-way-che-wung—creek with two portages—lake, 15 miles long (E & W) route crosses it. Atekepemeska—portage—lake, one mile—portage—lake, 60 ch.—portage, 40 ch.—lake, two miles—portage, mile and a half—Kenogaming lake. The same Indian informed me that around Atekepemeska lake, was a fine belt of large red pine twenty miles by six in extent.

The portage out of Mesumekenda is at the end of a bay opposite the entrance. On this bay are seen examples of very coarse granite, traversed by bands of hard barren quartz. The portage crosses similar rock for about 30 ch., all burnt and the trail hard to follow.

The shores of the next lake, Kapemichekama (Cross) lake, are almost destitute of green timber. The route lies straight across, and then ascends a small stream, with a rapid to a little lake. Across this lake we enter the creek again, and make a short portage on the right-hand side to Shangemequagama (Sandy Beach) lake.

As indicated in its name, this body of water is surrounded by sand ; the country is much lower, with black spruce scrub, and the water has the white appearance seen near the watersheds.

Passing through this lake we enter the creek again, ascend a rapid, and traverse a small lake to a second stretch of creek, with three small rapids, showing red hornblende granite.

This brings us to Machegamiching, or Little Branch lake, showing marshy shores at first, but high hills of gneiss at the southerly end. A half mile portage over rough burnt sand, filled with boulders, leads out of this lake to the next, but it is so badly blocked that preference is given to the river, which necessitates four short portages.

Matastagan (After Cross Land) lake is decidedly marshy, and is constricted in the middle, where an easy rapid occurs.

The portage out of this lake is very hard to find, in fact no clear trail exists. It is advisable to keep the west shore, after passing the small rapid above mentioned, and after passing a marshy stretch, run in through the reeds, south of the point bounding the marsh on the north. Here we portage 25 ch. N. W. over semi-burnt country, to a marsh and creek, which after making another portage over sand and boulders brings us to a small lake, the head of the Mattagami waters.

A two-mile portage over barren burnt sand with boulders and bare Laurentian gneiss gives access to Rice lake, called in Indian Kanagushka or Itch lake, probably on account of the irritating effect of the rice husks.

Rice lake may also be reached by following up the river from Matastagan on which are six short portages, to a lake with rocky barren shores. A short portage out of this lake leads to a fine sheet of water, Pebonishewening (Winter Staying Place).

This lake is five miles long by three in width, and is entirely surrounded by burnt country, except the northern end, which enters a green belt of some permanence. An expedition north revealed a somewhat rough country, wet in places, but clothed with large spruce and poplar in ferruginous sandy soil. A portage out of this lake near its northern end leads into a small lake, which enters Rice lake by a creek at its northern end.

The first described route is the one usually travelled, and the route through Rice lake is best understood from the map. All the northern part of Rice lake is green, and the rock gneiss and hornblende schist with pink felsites.

The river out of Rice lake is a chain wide, and contains a considerable volume of water. The navigation is as below :—

One mile, rapid.
Sixty chains, rapid.
One mile, rapid, and portage on north.
Half mile, rapid, and portage on north.
One mile, rapids.
Half mile, lake.

On this stream are seen outcrops of granite with inclusions of dark hornblende schist, the whole much resembling an igneous breccia. Burnt areas again occur towards the mouth of the river, where it enters Sagetowwashka lake through a marsh, whence the name meaning "River coming out among Rushes." On entering the lake a long point will be seen on the opposite shore, about a mile distant. The course lies to the south of this, where we enter a deep bay, from the end of which the river rushes out by a series of heavy falls. On the easterly shore of this lake massive green diorites were observed, while the western side shows red hornblende granite, soft white schists and green schists of a harder nature. It is evident that a contact with Huronian rocks occurs here, and that the first indication of the change was seen on the river above.

Sagetowwashka lake also forms part of the direct route from Biscotasing, to Flying Post. For the map connecting this point with the railway I am indebted to Messrs. De Morest and Silvester of Sudbury.

Between Sagetowwashka and Matagaming lakes there is a fall of about 150 ft. in all, which is effected by eight rapids or falls, six of which require a portage. The first leaves a small bay south of the head of the river and passes the first series, where the river falls 50 ft. over dark green and mottled schists. A mile and a-half below is the second portage, on the left side and about five chains long. The river falls ten ft. over dark green schists splashed with quartz. A mile below this portage the Woman river enters on the south side, and another half mile brings us to the third portage, also on the same side, and passing a fall of ten feet over syenitic rocks, green schists with pyrite and crushed granite.

A quarter of a mile of calm water leads to a rapid which is easily run, and the same distance below it is a series of falls where the river drops 40 ft., and a portage of 25 ch. is provided on the north side. The rocks are various kinds of Huronian schists. I noticed here some evidence of the presence of prospectors, but I saw no rock of a very propitious appearance. Twenty chains down is a rapid to be run, and a half mile lower a succession of falls, making a descent of fully fifty feet. This obstruction is passed by two portages on the southerly side, the first of 10 ch. into a small creek, and the second of 20 ch. out of it into the head of Matagaming lake. All along this stream the country is very rough and is covered by an old brulé, grown up with young poplar; the soil is sand throughout, and at the last two portages rises into hills of considerable height. Magnificent locations for water power are afforded by the heavy descents in short distances. The rocks, as already stated, consist of various Huronian schists, all striking east and west and dipping at high angles.

For about seven miles Matagaming lake is narrow and river-like, traversing an exceedingly rough Huronian area of high barren hills, consisting of various schists traversed by and interlaminated with some large belts of coarse, almost porphyritic hornblende granite. Towards the lower part of this stretch sandy hills soften the extreme ruggedness of the scenery, and bear signs of having been once clothed with white and red pine. The burnt barren condition of the country would afford every facility for systematic prospecting, and the general appearance of the rocks is not unfavorable, as the contacts of the granite masses are quite likely to prove auriferous. I regret that the necessity of connecting with Mr. Niven on the Ground Hog river rendered it impossible to make overland trips at this point.

A short distance beyond where the lake begins to widen, the big Northeast bay enters through a narrow channel. In this vicinity are hard gray dioritic schists and light green varieties, while soft sericite schists crop out on the east shore about a mile below. From here to the end of the lake is about four miles. The river does not flow out at the extreme end, but at the west side about half a mile from the end. Hard schists are the characteristic rocks at this end of the lake, all striking east and west and dipping 70° to the north. The lake at this end is well timbered, with the exception of some burnt areas on the easterly shore. The river flows N. 30° E. about three miles and averages three chains in width. The current is gentle, but gives place to a strong rapid, easily run, however, just where the river enters Ground Hog lake. It is covered by a recent brulé, said to have originated near Chapleau, which again approaches the river below Ground Hog lake. Immediately on entering the lake, we approach Flying Post, an important station of the H B. Co , in charge of Mr. McLeod.

Rock exposures are not common on the lake, but soft friable schists striking east and west occur a mile down the river. Three and a-half miles down is the head of the canoe route to the Pishkanogama river, and less than a mile below is a heavy rapid which can be run by experienced men. Below, the river turns sharp to the east, and on straightening out to the north plunges down a still worse rapid, Kaskemene Pow-wa-tic. The rocks here are soft white schists, which would make excellent whetstones. For five miles the current is fair, and the stream then passes through a narrow gorge in green diorite, and just below falls 10 or 12 ft., Me-ke-se wa sun rapids. A portage of five chains is necessary on the west side. At the foot of this portage six different schists are visible, as well as the dike of diorite to the existence of which the rapids may be due.

About two miles down very hard schists with pyrite, as well as massive green diorite, occur at another rapid to be run, at the foot of which a 25 ch. portage on the west side is necessary to pass the Ostandigististagan falls. A massive diorite, N. 20° W., occurs here at the foot of the portage; above, the rocks are Laurentian. I believe the actual

contact to occur above both these rapids. A mile further is nearly half a mile of heavy rapids, which can be run by large canoes only; a portage exists on the west side. A mile and a-half more brings us to Sa-ha-wa-che-wun rapids. This also can be run, but for small canoes a portage is necessary on the west side.

A course of two miles, after passing the mouth of a large stream, the Sturgeon river, brings us to the Ki kenda Onegum (Kettle Portage), which is 25 ch. long, and on the east side. Ka-sing-ge-ke-che-wun (Young Pine) rapids, with a portage of ten chains on the west, occurs two miles below the Kettle Portage, and is succeeded, at a distance of a mile and a-half, by the Ka-gas te-wa-tang-ga sing rapid, with a short portage over a sandy hill on the east side. Three miles of clear navigation through a somewhat lower country brings the voyageur to the Wa-be-gash-ic rapid, which can be run. A little more than two miles leads to a small grassy island on the east side, where the line crosses at 44 miles and 51 chains. Just below the line is the Chick-a-wab-skung rapids.

From these remarks on the navigation of the Ground Hog river it will be seen that it is very difficult and dangerous. Below the line it is said to be still worse, with long heavy rapids. These considerations deterred me from attempting any further exploration with my small canoe. No one should make the trip down this river without the services of a first-class canoeman, and one well acquainted with the region.

Two miles east of the river the line crosses Wa-wa-yes-kat ching lake. The country between is low and wet, with windfall and brulé. A portage connects the lake and river a short distance south of the line. The lake shores are mostly low, and consist of clay, which continues ten miles to the east.

The whole region to Mattagami river is low and level, with only occasional rock exposures. Mr. Niven reports the last Huronian rock to the east of the Kamiskotaia river at 27½ miles.

While ascending the Ground Hog river on July 24 numerous fragments of wood and floating debris indicated a storm to the south, and on arriving at Flying Post Mr. McLeod informed me that a heavy thunder storm from the w s.w struck the Post and was of sufficient violence to dislodge logs in the buildings and to lift his large freight canoes bodily into the air.

A direct route to Pishkanogama lake leaves the Ground Hog in the bend below the lake, but as it involves three long portages, as well as others, it is used as a winter route only.

The trail followed leaves the river, as indicated previously, at a point about seven miles below the post. The route is given below in the form of brief notes.

Portage: N.W., 50 ch., sand, small pitch pine.

Lake: 15 ch., north.

Portage: N., 40 ch, sand and gravel, spruce.

Lake: N.W., 30 ch.

Portage: W. 10° N., 1½ miles, first part level and sandy, second part hilly with sand and boulders. exposures of bright green schists.

Lake: 12 ch. W. 20° N., narrows, 20 ch. W. 40° N.

Creek: 20 ch.

Portage: North side, five chains, green Huronian schists, with sugar quartz, striking E. and W.

Lake: Course along south shore about one mile. Contains several islands of white mica granite or gneiss.

Creek: 10 ch., Laurentian boulders.

Portage: 20 ch., W. 10° N.

Lake: S 10° W., 60 ch. to narrows. Course along west shore to creek. On this lake are seen gray quartz schists, fine gray gneiss, green schists resembling protovermiculite schists, friable white hydromica schists, and brown ferruginous examples with pyrite and copper pyrites, an assay of which gave no gold. The average strike is N E by S.W. and the dip variable. The soil is sand, with some clay, and would make a good light agricultural soil.

River: N. 30° W., 1½ miles, very crooked and swampy.

Lake: Course 1½ miles into northwest corner of lake Some small red and white pine. Rocks:—various schists, hard gray kinds with pyrite, soft white an white-weathering examples, and green hydromica schists with pyrite, als

massive green diorite and diorite schist with pyrite. Under the microscope the darker of these schists shows a fine quartz and felspar matrix, with much altered hornblende in larger crystals.

Portage: 10 miles, w. 20° n. First part low wet windfall; second half green with poplar, dry soil, largely sand.

Lake: Small, marshy.

Portage: Half mile, dry, hard, schistoze and massive gray rocks, probably altered diorites.

River: About five miles to Pishkanogama river, several rapids, two portages, both on south side, the first about a third of a mile and the second a little more than a half mile. Soil is fine white sand; timber improves as we approach the river.

This stream is known as the Muskego, or Swampy river, and the name is well deserved, for above the portage it flows out of a low swampy lake, with peat bogs and small black spruce scrub. The same character obtains for some miles up the river above this lake. This country more resembles the low lying peat bogs of James bay than any other seen this summer.

PISHKANOGAMA LAKE AND RIVER.

Pishkanogama lake may be reached by a fairly good canoe route from Ridout station on the C. P. R. This route, as shown on the map, is from an Indian's sketch, and I think is substantially correct. The lake itself is about 25 miles long, the last 10 miles being narrow and surrounded with high gneiss hills, particularly on the eastern side. The rocks show many minor variations, and contain many belts of coarse red binary granite, particularly near the northern end of this narrow southern arm. At a second narrows, about four miles from the northern end of the lake, a belt of Huronian rocks crosses the course, striking a little to the south of west and dipping 75° to the northward. This belt consists of diorite and diorite schists, and talcose foliated green schists, with sugary, barren quartz. Two other belts of diorite, much mixed and contorted, also cross the lake at the points indicated on the map. The soil in this region is sand, and the timber of fair size; considerable pine exists on the northern and eastern shores, the largest and most continuous grove seen this summer. The whole district shows evidence of having once been covered with this timber. The presence of these pine groves, and some beautiful and extensive sand beaches at the northern end, with an open pitch pine region inland render this lake highly desirable as a summer resort, but of course the difficulty of access renders its use for this purpose impossible at present. Near the head of the river at the north end there are several Indian houses and a winter outpost of the Hudson's Bay Co.

The route does not follow the river, but a portage is made from the sand beach about a mile to the east. This trail is a mile and a half long, a little east of north, over sand with pitch pine and some fair red pine. From this portage to the Swampy river is about five miles. Below the portage are some green schists, followed by 20 ch. of rapids to run, and then a small fall with a portage of three chains on the east side. The rock here is gneiss, but below dark gray schists and streaked white and green examples occur at several points above the Swampy river; most of these seem to strike northwest and dip at a high angle to the southwest.

A half mile below the Swampy we run a rapid over boulders, or portage on the west side. Another mile and a half brings us to another rapid of some length; most of it can be run, but one or two places require a lift out, and it is somewhat difficult to stop in time. After a half mile of good water succeed 60 ch. of shallow rapids, which are best descended by poling, as the water is too low to run free. All these rapids can be passed by two portages on the east side, leading into and out of a small lake. Below the last rapid we enter a crooked lake. The course lies to the left of an Indian house, which will be seen on a point to the west of the entrance of the river.

One and half mile below this lake a fair sized stream enters on the west side, and a mile and a quarter below it a somewhat larger river, the Goose, enters on the same side. This is the route to the Trout river, to be subsequently described.

Below this river is an island showing gneiss, and then a rapid in two cascades, both of which can be run. Twenty chains lower is another rapid over gneiss and mica schist;

there is a sharp fall of three or four feet, and although it might be run I found it advisable to pass down to the west of a small island and make a lift out.

The next rapid is a mile and a half down ; it is fairly heavy and a portage can be made over the rocks on the west side. Some swift water follows, and then two falls, the first of 6 ft. and the second of 15 ft., over coarse banded gneiss ; both portages are on the west side, and short.

Just below this portage we enter an extensive burnt area, extending as far as the junction of this river with the Ground Hog. No more rapids are encountered until very near the confluence, below which no explorations were made. Ten or twelve miles down a large creek enters on the west side. This shows clear water and a coarse sand bed. It is interrupted by falls, rapids and drift wood a few miles up ; along its shores numerous signs of moose were seen. High banks of extremely fine sand are seen in this region, as well as some clay. Stratified clay, which I believe to be continuous with the Night Hawk area, appears a short distance below here. Eight miles below this creek, we meet outcrops of hornblende gneiss, followed by light and dark green compact schists. From this point down, outcrops are scarce, but where seen the rock was Huronian. Several streams enter one on each side being of fair size with gravel bottoms. The land is all clay, and looks favorable to agriculture. The line crosses at 63 miles. The country east to the Ground Hog river is level and sandy, and the only exposure seen was one of Huronian schist at 53½ miles.

ROUTE TO TROUT RIVER.

The Goose river at its mouth is about a chain wide, with low green shores, which give place to burnt areas a mile and three quarters up. A mile further are several small islands and a rapid, with a portage of half a mile on the south side, over gneiss covered by a partial brulé and windfall. Just above are two small rapids to pole, where we again enter the green bush, and a half mile beyond make another portage of 10 chains. The soil here is partially clay, but it can not be said to prevail in this district. Above is a small rapid, and then five miles of clear navigation to the last rapid, with a portage half a mile on the north side into Goose lake. The soil is fine white sand, with fair spruce and poplar, covering Laurentian territory, with occasional outcrops of gneiss. Goose lake is a narrow sheet of water, lying north and south, and is fed by three main streams The largest of these rivers enters at the southwest corner by a rapid, with a fall of five feet, and a rock portage on the southerly side showing coarse porphyritic gneiss. Just above is another portage on the west side of nearly half a mile, to a long narrow lake of five or six miles, showing green shores and occasional outcrops of gneiss, very garnetiferous in places Above the lake the river is interrupted by many rapids, some of which can be poled, but numerous portages are necessary. Some recent brulé occurs, and at the point where I returned an extensive burnt tract of much older date was encountered.

The soil here is ferruginous sand, and the general appearance of the country very rough and decidedly different from the district traversed from the Pishkanogama to this point. The gneiss strikes northeast, and is coarse and well banded, and in places, especially at some rapids, presents a peculiar white and black appearance. Under the microscope it shows hornblende and large crystals of plagioclase, and probably some orthoclase. The hand specimen is slightly gneissoid in structure. It may be a variety of gneiss or a peculiar diorite, approaching monzonite in composition. The stream entering Goose lake at the southern end was also ascended a short distance, and found to be choked with driftwood ; a well used portage leaves the stream here, and traverses well timbered, fine sandy soil. It evidently constitutes a hunting trail, and was not farther examined.

The third stream into Goose lake constitutes our route, and enters the west side of the lake at the northern edge of a marsh about a mile above the incoming portage. On ascending this stream a short distance, a round pond is seen on the right. The portage leads out of the north side of this, and is about half a mile long over sand hills, with pitch pine and spruce. We now cross a clear water lake, about 30 chains in a northerly direction. The next portage is more than half a mile, and traverses fine open pitch pine and spruce sand hills, to a very swampy and dirty lake. The creek entering Goose lake flows out of this body of water and does not enter the last mentioned lake. The stream enters in the northwest corner, and near here is the portage which is a mile long,

over country similar to the last. It ends on a small creek with clear water, and sand and shingle bottom. It is very shallow and crooked, making it necessary to wade and drag the canoe in many places. Two portages are necessary, the first of ten chains on the right and the second of 25 chains on the same side, above which it is still stony and shallow, to a lake about a mile long. The whole of this stretch is through old brulé and sandy soil. It is necessary to force the canoe through the reeds to reach the end of the above lake, where we find a 25 chain portage on the right. This again leads us to the creek, which now expands into a marsh, above which ten chains of very narrow creek brings us to a half mile portage into Shenango lake.

The shores of this lake partake for the most part of the nature of the burnt sandy country above described. The portage out is reached by keeping straight across into the extremity of the deep bay on the westerly side. This portage is a mile and a-quarter long, still in the burnt area, and ends on a little lake (Height of Land portage). An expedition to the northeast, a distance of over three miles, showed the old brulé for a half mile, then a belt of green bush with much windfall, followed by a very recently burnt tract with trees still standing. Sandy soil and rough Laurentian gneiss were seen on this trip. The head of the portage out of this lake is somewhat hard to find; it should be looked for a little to the left of the small creek flowing out; it is about a half mile long, still in the brulé, and ends on a very dirty and shallow lake, difficult of approach and hard to paddle through. The next portage leads out of the northwest angle of this lake, is a mile and a quarter long, and traverses green bush. The succeeding lake is known as Kanonjapownakoka. Its easterly shore is green, but the rest is burnt, and many high hills are observable surrounding it, particularly one due north of the portage. An attempt was made to reach this elevation by a trip one and a half miles northeast from the north end of the lake. This trip revealed the old brulé, with young poplar and jack pine, and reached a small lake from which the peak bears N.E two miles. I had hoped to obtain a good view of the country from this hill, but so much time was consumed in getting around the lake, and climbing through the very rough brulé on the flanks of the hill, that the approach of night rendered it imperative to return to camp. The line crosses Kanonjapownakoka lake at 76 miles 35 chains The creek out leaves the lake a half mile short of the western extremity on the north side; immediately on entering it we make a half mile portage in the same kind of burnt bush (old sandy brulé), and descend the stream 20 ch. to a small lake, burnt all around. Below the lake the creek is a half chain wide, and the navigation is broken by a ten-chain portage on the left side, about two miles down. Another mile, and we enter a small horseshoe shaped lake, with a portage on the north side of the right hand arm. This trail is a half mile long, somewhat hilly, and, like the last lake and creek, lies in green bush, and the large burnt area seems to be permanently passed There is a considerable descent at this point, and the creek below traverses a marsh one and a half miles to the Trout river. The line crosses a mile and a-half above the confluence, at 81 miles and 39 chains.

TROUT OR MACOZENDA RIVER.

The Trout river presents shores strikingly different from the other streams entering the Moose river, as for some miles it is bordered by a wide marshy belt, and seems at some past time to have occupied a much wider valley, into which it now expands in places, forming lake-like stretches. It was ascended about 18 miles, and presented this character for half that distance, when the current increased a little and continued to an extremely picturesque waterfall of 20 ft. over gneiss, striking east and west, with a portage of six chains on the west side. Above, the water is good, but I did not proceed farther. The shores present in places exposures of highly garnetiferous gneiss, with bands of quartzite and felsite, and a few streaks of white quartzose schists resembling Huronian, but in such small masses as to be of no importance. The upper part shows high hills of sand and gravel, clothed in places with both red and white pine, particularly the former.

Below the line the river is of the same character, and receives several large creeks. About eight miles down the Kapiskasing river enters on the west; at about this point also the marshy shores cease and the river becomes a little more rapid, and enters a series of rapids a couple of miles from the junction.

The first portage is on the right side, and is reached by descending the smaller portion of the river to the right of an island. Gneiss, large spruce and cedar and some clay were observed at this point. Twenty chains lower is a rapid over boulders, with a three chain portage also on the easterly side. A mile more and we enter a third rapid, with about eight feet fall ; this is easily run. The river continues with easy current for many miles. Below the rapids the country gradually becomes more level, and none of the high hills of the upper portion are visible ; the soil seems to be all clay and muddy banks are continuous, while rock outcrops are practically absent. The timber also decreases in size on approaching the low land, and is represented by small black spruce and tamarac. Eight miles below the last rapid we enter an old bru'é which seems to extend many miles to the north, and is probably continuous with the big burnt area on the lower Pishkanogama.

Trout river rises in Trout lake some distance south of the falls, at the head of my explorations. This lake can be reached by a canoe route from Chapleau, which is said to be very difficult with long, heavy portages ; I could obtain no reliable description of this trail, and have made no attempt to map it.

ROUTE FROM TROUT RIVER TO MISSANABIE RIVER.

The Kapiskasing river, where it enters the Trout, is about half the size of the latter stream, and affords uninterrupted navigation for two miles to Kapiskasing lake, which is a fine sheet of water about five miles by three. Very little rock occurs on its shores, but two or three points show exposures of coarse gneiss. Both sand and clay occur, and the latter is well timbered by heavy spruce and poplar, while some pine occurs in the former, particularly on the east side of the long, thin south bay. Near the outlet there is a prosperous Indian village, with about a dozen substantial log houses and a winter post of the H. B Co.

There are no Indians here in the summer, but they come from Brunswick House in the hunting season. The soil is good, and potatoes were doing well at the time of my visit—Aug. 25. The line crosses the south bay and also the river, entering in the southwest angle of the lake. At the northeast corner a considerable creek enters, which was ascended and found to branch about a mile and a half to the northwest. The left hand division is the more important, and continues about five miles, turning more to the west, where it seems to rise in a large swamp. The soil along this stream is clay and some fine level stretches are met with ; it is rather wet, and much tamarac is present.

A few outcrops of gneiss are seen, and on the flanks of Mount Horden, a considerable hill lying just south of the creek, some diorite was found. On ascending the hill we encounter larger timber, but all much injured by windfall. Although I did not reach the summit, I regard this hill as well as those near the Trout river, and some south of Missanabie lake, as eruptive masses of diorite or diabase.

This creek is evidently much used as a canoe route ; it is well cut out, and where it flows out of the marsh a well trodden portage leads westward about three miles to a river nearly a chain in width. This trail traverses at first an open country of clay and rocky ridges ; it then sinks into a wet valley, where it crosses the creek ; beyond, it passes over clay ridges with poplar, alternating with low, wet areas with scrub spruce. The river at the end of the portage flows into Kapiskasing river ; on descending it a short distance, a tributary on the left enters from Gull lake. It thus constitutes a route to the Missanabie, but is not the one usually travelled.

Returning now to Kapiskasing lake, we find the Upper Kapiskasing river entering by a shallow rapid at the southwest corner of the lake. About three miles up a portage of ten chains on the east side is occasioned by a fall of ten feet. Up to this point the stream has traversed fine clay soil, with large timber. It now becomes swifter and is broken by rapids, a five chain portage being necessary twenty chains above the last. The soil is still clay, but lower and with smaller timber, for three miles to the next portage, of about half a mile over sandy hills with some clay. Above this portage the stream is smaller, and in fact a junction occurs in the rapids, which is not visible from the portage. Another portage is required, after only ten chains of paddling ; it is on the west side, and is five chains in length. A crooked, narrow stream succeeds, broken by several smaller rapids and a heavy fall of 20 feet, with a short portage on the east side,

over a hill of sandy clay. Along this stretch small tamarac and spruce predominate. Above the portage is one rapid to pole, beyond which we soon enter Wart lake (Way-che-che co-me ka). The shores of this lake are for the most part sandy, with only occasional exposures of gneiss in the more northerly parts; towards the south, however, the country is more rocky and elevated, and has been swept by fires. The lake consists of two southerly arms, with a lift out between them, and a northerly extension. The route lies up a considerable creek, entering the west arm about a mile from the southern end. This stream is rather tortuous and traverses a continuously low country, which appears to consist of clay, at least in places; the river bottom, however, is sand. The timber is small, mostly spruce and tamarac, and seems to represent an old brulé.

About nine miles up this stream we turn to the right, into a small creek not more than eight feet wide at the mouth, and very shallow. It traverses a marshy tract of country, and is so choked by overhanging brush and its volume is so small that throughout its length (five miles) it is necessary to pole. About half way up we touch a small marshy lake of two bulbs, showing some exposures of gneiss, and the large marsh seems to be bounded by some high gneissoid ridges, covered by brulé of considerable age in sandy soil.

Near the head of navigation on this stream there is a junction with another branch, and just within the left hand fork is a portage of over a mile in a westerly direction, showing open pitch pine groves in sand. This trail ends on the creek very near its origin in Ka-ka-na-qua lake. Some high exposures of gneiss are seen here, and very high gneiss and sand hills to the northeast of the lake; to the east of these hills is a pronounced valley with a small stream flowing north. This valley has almost perpendicular gneiss cliffs in places 100 ft. high, and is crossed by a transverse ravine in which are several marshy lakes, one of which is crossed by the line.

A canoe route leaves Kakanaqua lake in the northeast angle, and by means of these lakes reaches the creek which probably communicates with the river from Gull lake, and thus furnishes another route to Kapiskasing. From the top of these gneiss hills a good view was obtained of the country to the north and east, which seems to be very rough, with many elevations of notable magnitude

The route leaves Kakanaqua lake by a portage out of the end of the southwest bay. The trail is a half mile long over burnt sand hills, and ends on a small lake 20 ch. in width. The next portage is due west 30 ch. The first part is sand, with poplar and spruce, like the country east of Kakanaqua lake; the latter half is lower, with scrub black spruce. Another 20 ch. lake (Little Bear lake) follows, then a portage of 15 ch. over burnt sand hills. This brings us to a long, narrow and rather dirty lake (Skunk lake), near the north end of which the line crosses at 27 miles and 14 chains A trip east of the lake shows an extensive brulé grown up with young poplar and jack pine. The line strikes this brulé at 93 miles 54 ch. and continues in it across Skunk lake to 98 miles 54 ch. At 96 miles 55 ch. is the summit of the ridge, with a drop of 180 ft. into the valley to the east. This point is sufficiently high to show Mount Horden, which bears due northeast magnetic.

The water of Skunk lake passes out by a creek at the northern end, and a portage of nearly half a mile is required to reach the navigable part of the stream. No further obstruction occurs to Gull or Kioskwabic lake, a distance of three miles This stream has a sandy bottom and is burnt all the way down. The lake has sand beaches, and seems to be bordered by green timber; its waters flow out by a considerable stream at the north. This river was descended a short distance and found to become very rough, with a descent of a hundred feet; a portage passes this part, but it is badly choked by windfall and is over very rough country. This creek leads to the Trout river, and is part of the route which connects with Kapiskasing by the long portage near Mount Horden. We are not yet in Missanabie waters, although the portage east of Skunk lake is the height of land between the Upper Kapiskasing water and that of Skunk lake, Gull lake and Gull river, all of which, however, eventually reach the Trout river. The portage out of Gull lake is 10 ch. long at the western end and over sand with good timber. This is the height of land portage between the main rivers; it will be seen therefore that the summit of the divide lies much nearer the Missanabie than the Trout. Beyond the portage are two small lakes connected by a short creek (Bittern lakes), and then a 15 ch. portage over a sand hill of 75 ft. elevation to Sa-gan-de-ba (Catch you by the Hair) lake. A few red

pines were seen here. The line crosses Sagandeba lake near its south end at 100 miles 25 ch. A creek enters at the south end which seems to drain a low stretch with many small ponds and lakes. The line on leaving the Skunk lake brulé traverses a region of large timber, but much injured by windfall. The route does not pass through the lake, but crosses the northern bay and leads out by a portage near the outgoing creek. This trail is a half mile long over sand with good spruce, and enters the creek which we follow a mile through low tamarac country to a small shallow lake (Sucker lake) Below we continue on the stream (Flying Post Brook) a mile to a portage on the left side a half mile long, showing some clay soil and a ridge of diorite, crossing the Laurentian rocks about north and south. For three miles the stream runs through good sandy clay land with fair timber to a rapid with a portage on the south side, followed by a 15 ch. portage on the right over sand. A quarter of a mile below we enter the Missanabie river, the most westerly of the great rivers of the Moose system and the favorite route to James Bay.

In the first half mile above Flying Post Brook are five small rapids, none requiring a portage. A few miles above Hay creek a considerable stream enters on the south side, where the river turns to the east. The aspect of the country along this stretch is low and marshy, with a clay soil along the river at least. This is probably of alluvial origin, as we generally encounter sand inland.

Hay creek is about 20 ft. wide, and issues from a large marsh with grass, which continues for five miles or more up stream. A mile up considerable diorite crops out on the shore, and to the west, beyond the marsh, is a high rocky ridge formed by a main and several minor dikes of diorite, striking north and south.

Several other hills in the region show the same structure. The country here is burnt, and seems to form part of an extensive brulé coming from the southwest and crossing the main river above Hay creek, thus surrounding the eastern end of Missanabie lake and stretching to the south.

About three miles up the creek forks into two nearly equal branches, both of which were explored. The easterly arm rises to the southeast of a prominent hill visible from the junction of the two arms, four miles above which point the marshes cease and the stream becomes difficult of navigation, with rapids and logs from the old brulé. Sandy soil with boulders predominates.

The westerly branch rises to the south of Missanabie lake. Six or seven miles up is a rapid, beyond which the stream seems to be continuously bad. The country is essentially similar to that seen on the east branch, old brulé, sandy soil and exposures of gneiss. This gneiss is highly hornblendic, and contains fragments of pre-formed gneiss and dark mica schist; the strike is northeast and the country rock is cut by some belts of very fine porphyritic diabase, striking about east and west. Diorites, which are evidently altered diabases and contain pyrite, occur in some narrow dikes.

East of Hay creek the country shows a succession of gneiss ridges, running north and south, with low wet tracts between. The high land is fine slightly argillaceous sand, and has very large spruce, poplar and pitch pine timber, much damaged by windfall. The lower tracts are filled with a tangled mass of cedar and swamp bushes.

The line crosses Hay creek just below the fork; to the west the soil is sandy clay, with just enough clay to render it slightly adhesive.

The Missanabie for four miles above Hay creek traverses a low region with tamarac and cedar; it then falls about six feet over boulders. The rapid is in two sections; both can be poled, but a little used portage exists on the west side.

Above the rapids the country is more rocky, and a mile and a half up is a fairly heavy fall, with a short portage of five chains on the south side. Here the rocky burnt hills reach the river; and above also, in the lower river bank country they are not far distant inland.

Above this last portage we enter Missanabie lake, and on rounding a point on the south side arrive at New Brunswick House.

A winter road connects this post with Hay creek, and according to Mr. J. Spence the officer in charge, traverses a continuously low swampy country.

At Brunswick House I obtained much valuable information, especially regarding the upper waters of Hay creek, and other connections to the south and east of Missanabie ake. The whole region south of the lake has been burned, but occasional patches of

green are to be seen on the shore, as well as inland, as will be noted from the description of Little Missanabie lake. On both sides of Missanabie lake, as far as Ferry point, although gneiss hills are common, they are of no especial elevation, and are cut in many places by dikes of eruptive diorite. As far as this point, with the exception of a bulb at the northern end the lake, is seldom more than a half mile wide; beyond, however, it is of somewhat greater width, and the surrounding country is much more elevated. On the south shore, about four miles above Ferry point, we meet belts of diorite, striking s. 20° w., followed by more gneiss, and then a pronounced Huronian area showing massive and schistose examples of the green Huronian rocks, mixed with much diorite, and followed by light green schists, and white highly siliceous belts with pyrite. These rocks rise to considerable elevations (300 ft.), and extend to the peak of the lake and beyond. Many minor varieties of Huronian rocks were noted, all striking from southwest to southeast, and averaging about south.

North of Ferry point is a second division of the lake, stretching to the north and east. No rock but gneiss was observed either here or at the portage in the northwest angle.

The Upper Missanabie, or Little Missanabie river (Missanabie Shi Sibi) enters the lake by a very picturesque fall (Weasichawun) about five miles east of Ferry point on the south side. The portage is in the sandy bay west of the fall; it is about 50 ch. in length, over sand with pitch pine and spruce of moderate size only. The river above is about a chain wide, but of no considerable depth.

Navigation of Little Missanabie River:

First portage:—50 ch.
River: One mile.
Rapid: Pole, and run down.
River: One mile.
Rapid: Portage, five chains on west. Brulé, gneiss, dike of diorite.
River: 20 ch.
Rapid: Pole.
River: 15 ch.
Rapid: Portage on east side, ten chains.
River: Half mile.
Rapid: 20 ch., pole.
Rapid: Portage, 3 ch. on east.
Rapid: Pole.
River: 25 ch.
Rapids: Half mile, portage on west.
Rapid: Portage, five chains on east.
Rapid: Portage, five chains on east.
River: Sixty chains.
Falls: Portage, five chains on east. Fall of 20 ft. Gneiss.

Above this portage we immediately enter Little Missanabie lake, which is a very irregular sheet of water. Its shores were examined all round; the rock is all gneiss, with the exception of a few narrow dikes of diorite. Swampy shores occur at many points, and many stretches of low water with rice and other grasses occur. The soil is largely sand, and the timber is the usual spruce and poplar, with some pitch pine. Many burnt areas occur, and even the green bush is comparatively young. A short portage connects the two southern arms of the lake, from the more easterly of which connection may be made with the railway, but the route is not used.

To reach the railway from Missanabie lake, we make a short portage out of the northwest corner, and traverse a long narrow lake, about ten miles. This lake is surrounded by Laurentian rocks, with the exception of a narrow belt of Huronian about the middle. The portage is at the extreme end, and having crossed it we enter Dog lake, and are on the lake Superior slope. Missanabie station is about eight miles from the portage; the route is very crooked, and is best understood from the map. The line of survey crosses Missanabie lake about two miles south of the post, touches the northern bay and terminates at 120 miles, a short distance north of that body of water.

SUMMARY OF OBSERVATIONS.

Geology: The whole region embraced in this report consists entirely of Laurentian and Huronian rocks, the former being represented by gneisses of various texture and color, passing in many places by gradual transition into granite. I have made no attempt to map separate areas of granite, as it is impossible to delineate clearly their boundaries. Again, where masses of gneiss fade imperceptibly into granite, it is obviously incorrect to ascribe the latter to an independent origin. While true plutonic granites may exist here, and do of course exist elsewhere, my experience, as well as the evidence of authorities, would ascribe these granites to the same origin as the most-banded gneisses.

The Huronian rocks are much the same as elsewhere in northern Ontario, consisting of varieties of schists, altered porphyrites, crushed granites, felsites and quartzites, as well as one exposure of volcanic conglomerate on Mattagami lake, pointing to a pyroclastic origin, and suggesting the rocks of the Lake of the Woods. Many of the schists are well mineralized, and small seams of quartz are not uncommon, although no extensive outcrops were seen. Hard and highly siliceous schists are more common than the softer varities, and as the latter are more fovorable for gold it is advisable to note particularly their occurrence, as is done in the body of this report.

Gold seems to be well distributed over the region; in fact it may be said to occur in nearly all the Huronian belts, but generally in extremely small quantities. The richest specimen was obtained near the Pigeon Rapid on the Mattagami river, and I regard the region south of the trail to Porcupine lake as giving promise of reward to the prospector. The south arm of Matagaming lake and the river above show traces of gold, and a prospect might prove successful in that region. The Huronian belts are as below:

1. An area touching Muskegogama lake embracing the south arm of Minniesinaqua, and probably connecting with a larger mass to the east.

2. A north-eastern area, sending a spur across Kenogamissee lake, crossing the Mattagami at the Wawiatan portage, and the Ground Hog some distance below the line. This belt sends an arm across the line at 53½ miles, and bends off to the northwest.

3. The Matagaming lake area embraces the Ground Hog waterway from above Sagetownashke lake to below the Mehesewasun rapid. Its eastern boundary is approximately shown; its western seems to be drawn out into several arms, crossing the Pishkanogama at various points.

4. An area embracing the southwest bay of Missinabie lake and stretching into a narrow belt across Long lake.

It should also be mentioned that dikes of diorite break through the gneisses in many places, particularly around Missinabie lake and Hay creek. Eruptions of diorite I also consider accountable for many of the hills in the western half of the region examined.

Timber: More or less pine of very moderate size occurs at many points. The most important are as follows:

Upper Spanish River, Kenogamissee lake, Atchepemeska lake, Pishkanogama lake, and Matagaming lake.

The other timber is birch, poplar, spruce, tamarac and cedar. Much fine large spruce occurs on the first 12 miles of line, and also near the Ground Hog river. The middle part is scarcely as well timbered, but from the Trout river on the spruce is of excellent size and quality where not destroyed by fire; some particularly fine trees were noted near Sagandeba lake. Immense stretches of timber have been destroyed by forest fires. While it is impossible to accurately outline the burnt areas, a rough idea may be gained from the following list.

1. Belt crossing the Spanish river near its source, passing northwest and north, embracing Mesumekenda and neighboring lakes, and terminating as to its northwestern boundary on the west side of Rice lake.

2. A belt, seemingly from the southwest, surrounding the south part of Matagaming lake. Although only occasionally touching the river, this same area probably is continuous with burn patches below Ground Hog lake. Mr. McLeod of Flying Post says that this fire came from Unapleau, and travelled with wonderful speed under the influence of a high southwest wind.

3. A very large burnt area crosses the route between the Pishkanogama and Trout rivers, infringes on the former river below the falls, and is continuous to the north as far as explored.

4. The Trout river is green in places, but below Kapiskasing passes into an extensive burnt tract which may or may not be continuous with the last described region.

5. The rest of the burnt country must be summarized under one head as a region surrounding Missanabie lake, and stretching eastward nearly as far as Wart lake. This territory is by no means all burnt, but large patches of it seem to have been stripped of verdure by fires of different ages.

Despite the many fires, immense quantities of spruce and poplar suitable for pulp wood still exist, and much spruce of a sufficient size for other purposes.

Soil : Throughout the whole southern part of the territory explored the soil is sand ; as we pass northward patches of clay occur, as well as an admixture of clay in the sand. The continuous clay area, previously designated the Night Hawk lake clay belt, is of enormous extent. Its southern boundary stretches in an undulating line to the vicinity of lake Kapiskasing. Westward of this point it can not be traced, as both varieties of soil, as well as mixtures of the two occur. The boundary might be said to turn south at this lake, and to become lost in the vicinity of Wart lake. Sandy clay and sand predominate beyond.

For agricultural purposes this northern clay belt, as well as many patches south of the line, should prove excellent. Experience only can show if cereals will ripen in the climate, but I have no hesitation in saying that for stock raising the conditions are excellent. Grasses and roots thrive in this soil, and with proper winter protection there should be no difficulty in weathering the inclement season.

Water power : Excellent locations exist almost all over the region ; particularly I might mention Kenogamissee portage, Wawiatan portage and Lower Sandy portage, on the Mattagami River.

First Falls above Matagaming lake, Ostandigististagan rapid, on Ground Hog river Falls on Pishkanogama. Upper falls on the Trout.

First falls below Wart lake.

Upper falls on Little Missanabie river.

Game : Small game is very scarce in the whole district, partridge and rabbit being almost absent, but duck are more plentiful. Moose are not uncommon, and in some parts seem to be quite numerous; red deer also are seen, but I observed no signs of caribou. Fur bearing animals seem to be yielding the average returns; the lynx however has followed the rabbit, and the beaver is almost exterminated.

Before closing I desire to convey to the gentlemen mentioned below my sincere thanks for various personal kindnesses, as well as valuable information and assistance.

Mr. J. Miller, officer in charge at Fort Mattagami, and Mr. Joseph Moore of the same place.

Mr. McLeod, officer in charge at Flying Post.

Mr. J. Spence, officer in charge at Brunswick House.

Also to Mr. A. Niven, O. L. S., and to Professor Coleman of Toronto University.

COPPER AND IRON REGIONS OF ONTARIO.

By Dr. A. P. Coleman.

In accordance with the instructions of Mr. Archibald Blue, Director of the Bureau of Mines, the summer of 1899 was employed in the examination of the copper-bearing rocks of the Thunder Bay region, the iron range of Michipicoton and the copper deposits near Parry Sound. Professor Arthur B. Willmott took a share in the work as in former years, and with his usual efficiency. As the regions which were to be studied resemble in most respects the great copper and iron mining regions in Michigan and Minnesota, whose development is so far advanced, it was thought desirable to visit some of the more important mines in these States in order to become familiar with the country rocks of the ore deposits, with the character of the ore bodies, and with the methods used in developing them.

Leaving Toronto on June 20, we went by the upper lakes to the Sault Ste. Marie, and thence to Marquette in Michigan, where the iron mines were visited. The Keweenaw copper mining region was next examined, and a few days were spent on the Vermilion and Mesabi iron ranges of Minnesota. After a very instructive journey through these famous mining regions, Fort William was reached on July 1, and our work commenced on Canadian soil. Various copper and silver deposits were examined near this town and on Thunder bay, and an excursion was made by fishing boat along the coast almost to the boundary of Minnesota. We were then instructed by the Director to return to the Sault, and commence an examination of the Michipicoton iron range, which was attracting much attention at the time. This work was followed by a visit to the deposit of iron ore at Pic, after which we returned to Fort William to close up our affairs there, and then went to Toronto. This closed the summer's work for Professor Willmott, but I made an examination of the copper mining region about Parry Sound. When this was completed a short visit was paid to the region south of Georgian bay in order to measure the elevations of some of the raised beaches so well developed there, and the regular summer's work ended on September 2.

Two short expeditions were made later in the season, one to the eastern end of the Province to study the glacial deposits and sea beaches; the other in company with the Director to examine deposits of arsenical gold ore and of nickel-copper ore between lakes Temiscaming and Temagami.

During the summer our methods of travel were varied. On lake Superior a fishing boat was employed; in the Michipicoton country canoes formed the only mode of conveyance; while in the Parry Sound district horses were used on the backwoods roads.

As on former occasions, acknowledgments must be made to mining men, farmers and others interested in the development of the country for their hospitality and aid in various ways. Special thanks are due to the Messrs. Clergue of Sault Ste. Marie and to the officers of the Parry Sound Copper Mining Company for courteous assistance rendered in their respective districts The maps and reports of the Geological Survey of Canada were of course of the greatest service to us in the regions covered by them. We owe to the courtesy of Professor Winchell, Director of the Minnesota Geological Survey, a valuable set of maps and reports bearing on the iron regions of Minnesota, and the work of several members of the United States Geological Survey has proved of service in the preparation of the following report, especially that of Irving and Van Hise.

COPPER DEPOSITS.

As the first part of our summer's work on Canadian territory had reference specially to certain copper deposits near Port Arthur, the subject of copper mines in general will be discussed first. As an introduction to this, a brief account will be given of our visit

to the famous copper mining region of Keweenaw point in Michigan. This region has often been described, and for detailed accounts of it the reports of the Michigan Survey and Irving's Copper Bearing Rocks of Lake Superior, published by the U.S. Geological Survey, may be consulted

MINES IN NORTHERN MICHIGAN.

Houghton is the best starting point for a visit to the region, though the most important mines lie to the north of it. The well known School of Mines is established here, and under the guidance of the president, Mr. McNair, and other members of the faculty, we examined its collections and studied the geology of the neighboring mines.

The rocks of the region, the Keweenawan, overlie the Animikie and are perhaps of Cambrian age. They consist of great flows of basic and acid eruptives, and of brown sandstones and conglomerates, the whole broken by faults and tilted from 35° to 80° N.W. The basic eruptives are mainly dark gray diabase (trap) and related rocks very often having the amygdaloidal character, *i e.* they have been filled with steam bubbles before cooling, and the rounded cavities formed thus have since been filled with such minerals as calcite, epidote, zeolites, etc. The presence of these cavities proves that the rock flowed as a lava; for rocks cooled far below the surface, where the pressure is great, have no chance to let the steam expand. One variety of the diabase has a spotted look, very like that observed at Mamainse. The amygdaloids are a most important source of copper, which sometimes fills the cavities like shot. In other places the rock as a whole is much altered and porous, and irregular masses of copper occur scattered through it. The alteration products generally accompanied by copper are especially chlorite, epidote and prehnite, according to Prof. Seaman. At some mines the altered rock, in which mass copper occurs, is of a pale bluish green, probably because of the chlorite and epidote.

The acid eruptives are much less widely spread, since they formed less fluid lavas. They are generally red or brown, and include felsite, quartz porphyry and quartzless porphyry.

The beds of eruptive rock are very uneven in thickness, and cannot be traced for any great distance, as might be expected of lava flows. They are thicker and less interrupted by sediments in the lower part of the Keweenawan than in the upper part, where conglomerates and sandstones become more and more important, at last being almost free from eruptive rocks.

The conglomerates are generally brown or red in color, and contain chiefly pebbles of felsite and porphyry. In some beds they are rich in copper, especially in the Calumet and Hecla mine, where they furnish most of the output The upper sandstones seem to carry little copper, only one mine having been sunk upon them. Part of the upper series of sandstones is closely like the St. Mary's sandstone at the "Soo;" and it is possible that the Keweenawan passes up into these rocks. Owing to faulting the relationship of the two is not absolutely certain in the Keweenaw region.

Although most of the mines are on beds of amygdaloids, the amount of copper produced from the great Calumet and Hecla mine, which works mainly conglomerate, surpasses the whole of the others, so that most of the Michigan copper may be credited to the latter rock. A small quantity of silver accompanies the copper, not alloyed with it, but as the pure native metal. This is evidence that the metals have been deposited from solution, but the source of the solution is not wholly clear, though it is probable the basic eruptives, which still contain some copper sulphides, have provided most if not all of it.

Besides the beds of amygdaloid and conglomerate, some copper has been mined from fissure veins, but these are relatively unimportant.

The most extraordinary feature of this great copper region, second only to one other in the world, that of Montana, is the fact that almost the whole of the metal is native, even at the great depths to which mining has reached. This feature is found nowhere in the world outside of the Lake Superior basin, since in all other regions, after the gossan or weathered upper part of the deposit has been removed, sulphides, chiefly copper pyrites, are found. The purity of the metal and the ease with which it is extracted by simple crushing and washing, give the Superior region a great advantage over all others, and Lake copper has long led the way in quality.

The Keweenaw region can boast of the greatest mine in the world, the Calumet and Hecla, with the deepest vertical shaft in the world, the Red Jacket shaft, now about a

mile in depth. Mining, milling and smelting the copper can here be carried with ores very low in the metal; since the Atlantic mine treats ores averaging only 0.61 per cent., and no other mine surpasses 2.00 per cent, except the Calumet and Hecla itself, which reaches 3.05.

As the ore comes up from the shaft, the "mass copper" (large lumps of the metal) is selected out by hand, and the rest is taken by rail to the mill and crushed. Gravity stamps such as are common in gold mills are not used, immense steam stamps, somewhat like those of the Tremaine mill, being used instead. In the Calumet and Hecla mill on lake Linden, the stamps are said to crush 300 tons each per 24 hours, and cast iron stamp heads last only 3 or 4 days. The rock is not crushed nearly so fine as in a gold mill, however, and much of the rock is not so hard as gold quartz. There is an elaborate system of washing the material from the stamps, and the concentrates are of two grades of purity, the tailings being run off into the lake, which is rapidly being filled.

The smelting of the copper is a very short and easy process compared with that of other regions.

Copper has been obtained from Keweenaw point ever since the days of the mound builders; but the first real mine was opened in 1846. Since then the output of copper has steadily increased until, in 1898, 281,125 tons were produced. The Calumet and Hecla mine alone has paid more than $55,000,000 in dividends on a capital of only $2,500,000; and its shares, which if at par would be worth only $25, are quoted at $895. It should be added, however, that no other mine in the region has approached this level.

So far as the geology is concerned, every rock observed is found also on the north shore of lake Superior, at Mamainse, Michipicoton island, and between Nipigon and Thunder bays. The only important differences noticed between the two regions are in regard to the attitude of the strata, those of Keweenaw point being much more steeply tilted and more intersected with faults than the rocks of the same age on the north shore. It should be added, however, that on Michipicoton island certain rocks occur, such as a black pitchstone, which are scarcely found in the Michigan region.

COPPER AND SILVER NEAR THUNDER BAY.

As we had in the previous summer examined and reported upon the copper deposits north of lake Huron, at Mamainse on the east side of lake Superior and on Michipicoton island in the northern part of the lake, it was decided to investigate the copper bearing rocks on the northwest side of the lake, and to visit any known deposits of copper between Pigeon river on the Minnesota frontier and lake Nipigon to the north. Silver and iron mines in the vicinity of our work were visited also, and attention was directed to the relationships of the Huronian, Animikie and Keweenawan or Nipigon rocks of the district. Owing to the finding of an important iron range at Michipicoton, however, we were called to that region before our work near Thunder bay was far advanced.

Dikes and Sheets of Diabase at Sturgeon Point, Lake Superior. (Coleman).

Our first expedition was toward the Minnesota boundary, traveling in a small fishing boat with Ambrose Cyrette, from the mission opposite Fort William, as guide and boat-

man. As Ambrose had discovered many years ago one of the copper deposits we wished to visit, and also one or two silver mines, and had traversed much of the region as a hunter and prospector, he was specially suited for our work and performed his part of it on the whole very satisfactorily.

There are many references to the mines and their geological associations in the reports of the Canadian Geological Survey, the most complete being Ingall's report on Mines and Mining on Lake Superior. [1]

Leaving the Kaministiquia by the southern outlet, the delta deposits are not passed until Whiskey Jack point is reached. Here soft shales with harder layers rise a few feet from the lake and have a gentle dip, about 5° to the northwest. Proceeding south along the shore one sees evenly banded shales or slates, some layers hard, others soft enough to crumble in the hands, often with exceedingly uniform lamination, lying almost horizontally. Some of the thin harder bands are evidently laccolitic sills of diabase, though only an inch or two thick, since occasionally they cut across the slate from one level to another. Thin dikes of similar rock have been thrown into curves by the compression of the strata, and, at the same time, broken into rod-like portions. Larger dikes, some 20 feet or more in thickness, rise through the slate and cut a thick cap (or laccolitic sill) of diabase, the latter apparently sometimes 200 feet thick, near Sturgeon point.

About a mile southeast of the point large stretches of diabase interrupt the slate, rocks weathering into spherical masses, or having many paler greenish spots like certain diabases of the Keweenaw region near Houghton. It is possible that these rocks are eruptions of Keweenawan age.

In order to reach the copper bearing rocks we camped on Cloud bay, a few miles northeast of Pigeon river, and made an excursion inland. Following Cloud creek a short distance by canoe, we reached a farm with good fields of hay, but apparently abandoned; and then walked north over a rough and wet trail to the Pigeon River road, which we followed about two miles, and then struck across country to the northwest toward Cloud lake in the northwestern part of Crooks township, reaching sec. 4, con. II. As it had been more than 20 years since Ambrose had visited the location, of which he was the discoverer, there was some trouble in finding the place. The region crossed, before arriving at the copper mine, consisted chiefly of old lake deposits, forming several terraces; but here cliffs of slate and diabase of the Animikie rose from the level sediments, and to the southwest across Cloud creek there were hills several hundred feet high.

Very little work had been done at the so-called mine, two pits each 10 or 15 feet deep, and a heap of rock removed from them, being all that was to be seen. The openings are on a small ridge running for 100 feet in a direction of about 170° on a steep slope toward a small tributary of Cloud creek. The rock is undoubtedly amygdaloid, very like that of Keweenaw point, and contains small specks of native copper, as well as red and green earthy minerals containing copper. It is greatly weathered, and appears to have been shattered into irregular masses and then cemented with reddish brown breccia. In spite of its shattered condition the amygdaloid appears to be in place, and it is at least 30 or 40 feet thick, the lower part being buried under a talus sloping down towards the creek. We walked more than a mile along a ridge, which seems the continuation of the hill where the openings were made, but saw no more rock in place, though boulders of amygdaloid, of the spotted diabase and of red sandstone, all very much like the rocks of the Michigan copper region, were found here and there along the way.

There seems no doubt that a considerable band of Keweenawan rock, to some extent at least copper bearing, exists a mile or two southeast of Cloud lake; but it is much more easily weathered than the neighboring Animikie rocks, and so is mostly hidden under debris. Whether any parts of the band contain copper enough to be mined at a profit cannot be determined until much more development work has been done.

Another excursion was made to a copper location in Blake township, reached by a walk of 12 miles, principally along the Pigeon River road, which is falling into bad repair, so that at present much of it could hardly be traversed with a wagon where it runs through swamps. There are, however, many square miles of good looking level land, fairly dry and largely clay, along the road. Fires, which have run over the region, have destroyed most of the timber, so that the land could be easily cleared. Timothy and

[1] Geol. Sur. Can. 1887-88, part ii, H.

clover grew rankly along most of the road, and there is some pine in the valley. The road winds greatly, and nowhere touches rock in the part which we followed, though mountainous hills of Animikie rocks rise at points not far from it. The moose are so numerous as to work up the boggy road in places to muck. A path leads off to the east or southeast to the mine, which is about 2 miles from the road, and 3 or 4 miles southwest of Loch Lomond.

The mining operations, which were carried out under the management of Mr. Hardman as mining engineer, consist of a drift running 20 or 25 feet into the face of the steep hill, some trenches and a few small pits. The work has been done just beneath a very steep escarpment of Animikie diabase, in a long slope of talus, running eastward down to a small valley trending about north and south.

The drift was started in amygdaloidal rock fresher than that seen in Crooks township, with small amygdules filled, as in the previous case, chiefly with green delessite (?) and white calcite. In a great many of the lumps on the dump in front of the drift native copper can be seen, so that the rock looks well. However, the drift when entered proves to pass through the amygdaloid into boulder clay, and at the end it strikes solid fresh diabase, dark gray and not at all amygdaloidal, apparently the ordinary diabase of the Animikie laccolitic sills. From the work done it is evident that the amygdaloid is simply a very large separate mass or boulder. Lower down the steep hill-side there is another smaller mass of amygdaloid, about 200 yards from the first. The other small costean pits show no amygdaloid. Careful examination of the hill-side above the two boulders disclosed chiefly fragments of ordinary diabase, a little of the spotted diabase and some slate. An escarpment of slate, covered by a cap of coarse diabase, rises about 100 or 125 feet above the highest mass of amygdaloid.

The presence of these large boulders, or masses of copper bearing rock, may be accounted for in several ways. They may be parts of a great dike cutting the Animikie, or parts of a bed of amygdaloid forming a portion of the Animikie series, or they may represent small areas of Keweenawan rocks, remnants of a great sheet of them covering the Animikie, now completely eroded away, except where small patches have been preserved by walls of Animkie trap brought up beside them by faulting.

There are objections to the first theory, for dike rocks are seldom amygdaloidal, since the expansion of vapor necessary to form the bubble holes can only take place at or near the surface of the ground. At any important depth below the surface the cavities could not form because of the great pressure. The second theory does not seem borne out by the facts, since none of the large number of splendid escarpments of the Animikie along the shores of lake Superior discloses a bed of amygdaloid. In fact there is no evidence that any of the caps of diabase covering the hills of the region, and giving them the strikingly flat topped or *mesa* structure, were ever surface flows. Probably all of them were pushed in between the beds of Animikie slate as sheets or thin lenses at a great depth below the surface. Under these circumstances an amygdaloid could not form.

The third theory seems the most satisfactory, and would account also for the long ridge of amygdaloid rock in Crooks township. It is of course possible, but improbable, that the large masses of amygdaloid were brought by ice to their present position. If the third theory is correct, a trench cut at right angles to the escarpment to a depth of 125 feet should disclose any band of amygdaloid, protected by the harder rocks of the Animikie cliff, from which such masses as are found may have rolled.

Apparently this deposit is the one described by Dr. Lawson in 1890,[2] or not far from his locality, sec. 8 in con. VI. of Blake township. He inclines to the view that the rock is a dike, but at that time no development work had been done, and he could not know that the amygdaloid masses were apparently boulders. He mentions the occurrence of an outcrop of brownish red sandstone, which we failed to see, which suggested to him that some other theory might be more correct, e.g., the faulting down of overlying beds of Keweenawan (Nipigon) rocks. Samples collected by him were assayed by Mr. F. L. Sperry, then at Sudbury, with the following results:

Sample No. 1, 64 feet above foot of slope	1.39 p.c. copper.
" No. 2, lowest outcrop	0.27 " "
" No. 3, 64 foot level	2.88 " "
" No. 4, 64 "	3.57 " "

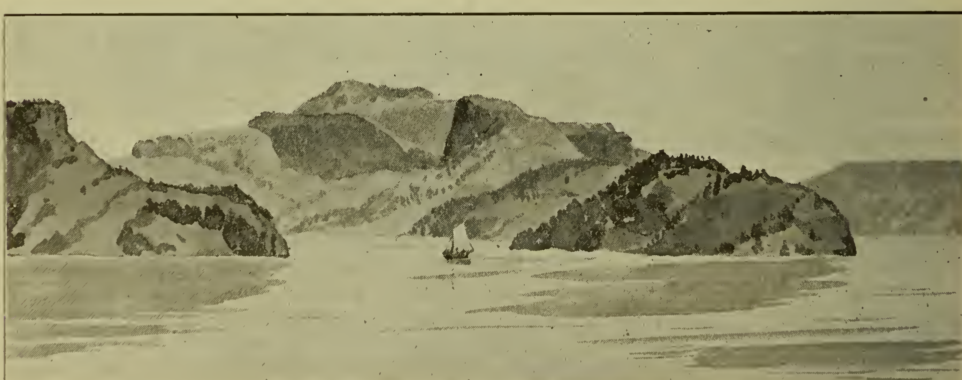
[2] Am. Geol. vol. v., Jan.-June, 1890, pp. 174-178.

Dr. Lawson mentions also the copper deposit in Crooks township, which he was not able to visit, but at a later time Mr. Hille of Port Arthur visited the spot and obtained specimens. He concludes that "enough has been advanced to show that the Animikie rocks of Thunder bay are worth careful prospecting for copper."

MCKELLAR'S POINT AND ADJACENT ISLANDS.

While in the Cloud Bay region we visited McKellar's point, which projects as a long rocky ridge between Little and Big Trout bays. It has the "mesa" form, a flat topped hill covered with a sheet of diabase, and rises 342 feet above the lake at one point. The

Shore near McKellar's Point, Lake Superior : Pie Island in the distance. (Coleman).



Trout Bay, Lake Superior. (Coleman.)

diabase (or gabbro) on top is coarse grained and in parts porphyritic, containing large glassy crystals of plagioclase felspar. A large dike of porphyritic diabase cuts it. Below the capping of eruptive rock are soft slates or shales, with some harder greenish layers, and also beds a foot or two thick of red quartzite, or perhaps felsite. At the Cloud bay mine to the north of the end of McKellar's point a somewhat thick cap of reddish quartzless porphyry forms the top of an escarpment, beneath which are thin fissile slates and thicker beds of bluish gray, less cleavable, slate Part of this slate has a ropy looking surface as if of lava, though this may be deceptive, and another part contains flat pebbles of darker shale or slate.

Three openings have been made on veins in the slate, a tunnel and a shaft at the western end, and a shaft filled with water at the eastern dump. Probably faulting took

place when the veins were formed, for a breccia of porphyry fragments cemented by calcite makes part of the dump. Calcite is the chief gangue mineral, and a little pyrites is the only metaliferous mineral seen. To the west of the mine there is a higher escarpment, perhaps due to faulting, where the porphyry is not to be seen, the capping being of spotted diabase with slate beneath. The same variety of diabase forms the point between Cloud and Little Trout bays. The rocks mentioned here are evidently similar to those so fully and excellently described by Bayley from Pigeon point in Minnesota, 6 or 8 miles to the southwest.[3]

On our return from Cloud bay we stopped at Caldwell point, opposite Victoria island, examining reddish granitic looking rocks almost suggesting Laurentian, and also at Jarvis island where a silver mine was worked at various times since 1869, but has long been abandoned.[4] The white dump of calcite forms a striking landmark against the dark trap rock of the point behind it. A considerable amount of white barite occurs also, and a little pyrite, zincblende and argentite. The adjoining rocks consist of a curious intermixture or breccia of diabase and a syenitic looking rock, as well as some slate. They will be referred to in the petrographic portion of this report.

THE SHORES OF THUNDER BAY.

We now turned back to Thunder bay, intending to study the relationship of the Animikie to the underlying Laurentian, and especially to the Huronian east of Port Arthur. We commenced our work at Current river, a mile or two from the town, where the black slate, covered in places with black trap, has been laid bare by the shallow stream but scarcely at all eroded, the banks consisting merely of the thin sheet of soil and turf covering the rock on each side. As Goose point is approached one notices that the hills in the rear are not flat topped, as they almost always are in the typical Animikie region, but present rounded, rolling forms and are of a whitish color, evidently consisting of Laurentian rock. East of the point coarse granitoid porphyritic gneiss shows itself, and then fine grained somewhat slaty green schist standing almost vertically, with a strike of about east and west. On the edges of the schist there are a few patches of basal conglomerate of the Animikie. If the slaty schist is Huronian, there must have been an immense gap between it and the almost horizontal Animikie which covers it.

The schist is faulted in places, and varies in strike and dip, at one point dipping 70° to the north with a strike of 50°. The band of schist can be followed a long distance along shore, and we estimated its length at 2 or 2½ miles with an observed width of perhaps half a mile, but we did not think it wise to attempt to map it in detail. Narrow veins of quartz occur interbedded with the schist, but not of much promise. Just west of Silver Harbor we found coarse gneiss at the foot of a bay, but could not see the contact between the two rocks. The contact at the western end of the band is an eruptive one, blocks and strips of the schist being enclosed in the Laurentian.

The point at Silver Harbor consists of Animikie, largely chert, which is beautifully banded with black and white, overlain a short distance inland by a bed of diabase which forms an escarpment. The old Algoma silver mine is situated here, but there is very little to be seen of its workings.

The 3A mine lies about a mile inland, and may be reached over a road so grown up with saplings as to be hard to follow. It is interesting as one of the few silver mines of the district located in rocks mapped as Archaean, so we made an excursion to it. The Animikie forms only a strip on the shore, after which a half mile of green schist is passed, then fine grained yellowish gray gneiss or granite in eruptive contact with it; then coarse diabase before the mine is reached. The rock at the mine is dark green and schistose, and similar rock, sometimes weathering red and at times pitted with small spots, which weather more easily than the rest, is found for more than a quarter of a mile north of the mine. Rocky hills beyond this consist of red porphyritic granite. A considerable amount of work has been done, but the mine has been closed for 13 years. The veins strike about 75° and contain quartz, calcite, a little barite and much pyrites. There are many intricate, narrow bedded veins in parts of the country rock, somewhat like the

[3] U. S. Geol. Sur. Bull. No. 109, 1893.

[4] Geol. Sur. Can., 1887-88, part ii., p. 43 H.

arrangement seen at the Alice A. gold mine near Shoal lake. Mr. Ingall's report on the silver mines of the region says that "ores of iron, copper, lead, zinc, nickel and silver with some cobalt and gold" occur in the mine, "the silver being found native and combined with sulphur and nickel"; and the ore is said to have been as rich as that of Silver Islet. One sample is stated to have assayed 25 p. c. nickel and 1.0 p. c. cobalt.[5]

On our return to Fort William we crossed the upper end of Thunder bay and coasted southwestward past lofty cliffs of sandstone. The rock is a rather coarse grained, pale gray freestone, affording large blocks, well suited for building stone. Along the whole shore there are about two hundred feet of sandstone which seems suitable for building stone, and has been taken up as locations for that purpose. As one advances toward Thunder cape some bands of red sandstone appear high up on the cliff. This rock is considered to be of Keweenawan or Nipigon age, though so different in character from the rocks of Keweenaw point. It rests on the Animikie, which can be seen cropping out as a low cliff of slate at the foot of the escarpment. A dike of diabase passes up through both Animikie and Keweenawan, not far from the eastern end of the mountain named Thunder cape. As mentioned in a former report, there is a fault of at least 1300 feet between the Keweenawan sandstones of the eastern end of the peninsula and the bold "mesa" of Animikie diabase forming the cape itself.[6]

Arriving at Fort William we found instructions from Mr. Blue to proceed to the Sault Ste. Marie in order to examine the iron range recently discovered in the Michipicoton district. Our plans for cruising along the north shore of lake Superior to Nipigon bay, and for a canoe trip to lake Nipigon, had therefore to be postponed.

A spare day before the leaving of our steamer was employed in visiting some supposed iron and copper deposits northwest of Port Arthur. The iron ores, which occur on Mr. Morgan's farm beside a creek, are rusty bands of Animikie rock, probably weathered portions of impure siderite; and the supposed copper mine is simply a shaft sunk in the ordinary Animikie rock, it is said, by a Chicago company. As it was full of water, nothing was to be seen in the shaft, but the material dumped from it consisted of blue boulder clay and a shaly conglomerate entirely different from the Keweenawan copper conglomerate. Copper is said to occur in the latter rock, but we found none in our brief examination.

IRON ORE DEPOSITS.

An account of our observations in the iron ranges of Marquette and Tower earlier in the summer will be of value, as showing the character of the ores of these famous iron regions and their accompanying rocks, for the purpose of comparing them with the new and undeveloped range at Michipicoton. No attempt will be made to give detailed descriptions of these ranges, but the main facts will be briefly presented. Those who wish to study them in detail will find admirable guidance in the publications of the State Surveys of Michigan and Minnesota and of the U. S. Geological Surveys. Of special importance are the monographs on the Penokee Iron-bearing District of Michigan and Wisconsin,[7] and on the Marquette Iron-bearing District of Michigan.[8] These two exhaustive works give very full accounts of the regions and are admirably illustrated. Their careful work has laid a foundation on which Canadian geologists may build in working out our own iron ranges.

THE MICHIGAN RANGES.

We visited first the Marquette iron range, easily reached by rail from the city of the same name. Most of the mines are near the two inland cities of Ishpeming and Negaunee, but the range extends from Marquette to Michigamme, a distance of nearly 40 miles from east to west. A short account of the geology of the region will be

[5] Geol. Sur. Can. 1887-88, p. 67 H.

[6] Bur. Mines, 1896, 6th Ann, Rep., p. 129.

[7] U. S. Geol. Sur., Monograph xix, by Irving and Van Hise.

[8] Ibid., Monograph xxviii, by Van Hise, Bayley and Smyth.

abstracted from Van Hise's outline at the beginning of Monograph XXVIII, and afterwards comparisons will be made between the rocks of the region, as observed by us, and corresponding rocks in Ontario.

The rocks of the district comprise three series separated by unconformities, the Basement Complex or Archæan, the Lower Marquette and the Upper Marquette. The Basement Complex consists mainly of massive and schistose rocks, not easily separated into sharply defined series, and includes the granites and gneisses generally called Laurentian in Canada, as well as green schists and eruptives, which would be classed as Huronian or Keewatin. Van Hise excludes all sedimentary rocks from his Archæan.

The Upper and Lower Marquette series, classed as Algonkian by Van Hise, include rocks which would in general be called Huronian in Canada. The Lower Marquette consists of quartzites, dolomites and slates, with the Negaunee iron formation at their summit. Only the last need be described. It is "from 1000 to 1500 feet thick, is non-fragmental, heavily ferruginous throughout, and contains the greater iron deposits of the district. It is therefore called the iron-bearing formation. Large quantities of intrusive greenstones are associated with the formation, the masses of which vary in magnitude from great bosses 2 miles or more long, and a half mile wide to small dikes. . . Upon the whole, the formation is soft, and occupies lowlands between the more resistant greenstones and the Ajibik quartzite. The formation is underlain by the Siamo slate or Ajibik quartzite into which it grades, and is overlain unconformably by the Upper Marquette series." Petrographically the formation consists of a variety of hornblende schist (gruenerite schist) or slate with magnetite, hematite or limonite, ferruginous chert, jaspilite (jasper rock) and iron ore. The chert and jaspilite are frequently brecciated, the others less frequently. "The sideritic slate is the original form from which the other varities of rock have originated. The ferruginous cherts differ from the ferruginous slates in that the iron oxide and the chert are largely concentrated into alternate bands." The jaspilite differs from the chert only in being stained red with included hematite. "The iron ores resulted from the concentration of the iron oxides through the downward-percolating waters. These concentration bodies usually occur upon impervious basements in pitching troughs. The pitching troughs are formed by the Siamo slate, the Ajibik quartzite, a mass or dike of greenstone, or by some combination of these. The ore deposits are likely to be of large size where, as a result of the folding, the iron bearing formation is much fractured, thus permitting the ready action of percolating waters. The ore deposits occur at the bottom of the Negaunee formation, within the Negaunee formation, and at the junction of the overlying Ishpeming formation."

The Upper Marquette rocks, the Ishpeming formation, consist of quartzite and a variety of actinolite (gruenerite) schist. At the base of the quartzite there is often a basal conglomerate above the Negaunee iron bearing series, showing that there was an interval of erosion between the two.

We visited first the Jackson mine near Negaunee, the earliest worked in the region, having been first opened in 1845. It is still working, though its best ores have been exhausted, and the ore still obtained is very siliceous. The present output is stated to be used for mixing with other ores in smelting. Large open cuts allow one to study the deposit without difficulty. The ore is largely a lustrous, gray, micaceous hematite, intermixed with thin seams of red jasper, often intricately folded and faulted. A talc schist of a yellow to brown color shows on the hill above, and on the lower side of the most easterly opening the same soft schist occurs, largely changed to impure brown iron ore.

North of the valley we found lean, jaspery ore, too low grade apparently to work. This band has a dip of about 70°, and reminds one of hills on the Mattawin west of Port Arthur, or near Magpie river in the Michipicoton region.

The Negaunee mine, which ships 600 tons per day of ore, running from 57 to 62 per cent. in iron, is situated in a valley to the east of the Jackson mine. The ore seems to be mainly soft hematite, with little or no jasper, and lies in lenses, sometimes 200 to 500 feet across and 50 to 100 feet thick, varying in quality, parts being too lean to ship. Dikes of a rock said to be diorite cut the ore bodies, now largely turned to "paint rock." North of the mine gray slate shows at a railway cutting, and still beyond is a ridge of white quartzite, much like that of the typical Huronian at Echo lake, though the dip is higher.

The Lake Superior mine at Ishpeming was visited, and here also there are large open cuts, showing hard micaceous ore with some jasper. The workings are from 300 to 800 feet deep, and the hard Bessemer ore is said to run 65 per cent. of iron. The iron bearing rocks of the Negaunee formation occupy usually the valleys, while masses of greenstone rise as hills on each side, and drilling was going on at several places in order to prospect for new ore bodies. Test pits were being sunk also, in some places penetrating great thicknesses of clay and other drift deposits. This is suggestive for our own Michipicoton range, where the valleys have not yet been carefully prospected.

VERMILION AND MESABI RANGES.

Arriving at Duluth by boat, we made an excursion to Ely, in the Vermilion iron range of Minnesota, which displays in a general way the same relationships in regard to the ore bodies as may be seen in the Marquette region. A trip was made by canoe to the north in order to examine the lower Keewatin as mapped by the Minnesota Geological Survey, and to see its contact with the Laurentian.

The rocks observed correspond petrographically to those of the Keewatin of Ontario, and a deposit of magnetite in hornblende schist occurs on the Brandine property, somewhat like the Atik-okan iron deposits but very much smaller. Dikes of granite penetrate the green schists, as near the border of Laurentian bosses in Ontario.

The most important mine at Ely is the Chandler, and some time was spent in studying its surroundings. The mine is worked by deep mining and caving, and the deep kettle-shaped opening with its rock wall, affords good opportunities to examine the conditions. Red jasper and bluish chert are associated with the ore, which consists of hard and soft hematite, partly dark red in color, partly "blue," i.e. bluish steel gray. The latter variety of ore is often hard enough to scratch steel. Much of the ore is porous, consisting of angular fragments cemented by a later deposit of oxide, a condition greatly facilitating mining. It is probable that the hard angular fragments represent jasper, now replaced by ore. On the northwest side of the opening gray green chloritic schist and altered diabase are seen, dipping 60° to 80° to the southeast. Part of the schist is paler, almost yellow, perhaps sericite schist, and other parts are turned to a brown or purple rock, softer than the rest and approaching iron ore in character. The face of the opening is slickensided in places.

On the southeast side of the mine green chlorite schist is seen, and afterwards altered diabase, so that the ore body appears to lie between bands of altered diabase and chlorite schist. Captain John Pengilly, manager of the Chandler Iron Company, was good enough to give much information regarding the mine and its surroundings. The ore body was in the beginning about 450 by 500 feet in area, and mining has already gone down about 700 feet. There were 40 feet of clay on top of the solid rock, then jasper, which thickens to the eastward. This is really only one of three lenses of ore which have been proved to exist, all parallel to the strike of the country rock, the first that on which the Chandler mine is situated, its eastern portion belonging to the Pioneer mine; next the Zenith mine, and then the Savoy. The Chandler however is the only mine which has yet been largely worked. There are about 500 feet of jasper overlying the eastern end of the Chandler lens, which belongs to the Pioneer mine. The Chandler ore is said to run 65 p. c. iron, with only a trace of sulphur and 0.038 phosphorus, and is all of Bessemer quality. Over 5,000,000 tons have been taken from the mine, which was opened in 1888; and it was expected that 800,000 tons would represent the output for 1899.

It must be remembered that this splendid mine is only about 20 miles from the boundary of Ontario, that two other lenses of ore have been proved to exist between it and the boundary, and that the band of country rock enclosing them has been proved to cross into Ontario. The fact that some of these ore bodies are heavily capped with jasper shows that extensive exploration with the diamond drill may be necessary to locate similar lenses on our territory.

The Tower iron mines were visited the following day, on a continuation of the same range but 20 miles to the southwest. Their general surroundings are much better exposed, since bare hills give access to the rock. Part of the mine was worked as large open cuts in a high hill, displaying well the enclosing country rock. Apparently the ore was capped by banded jasper, often crumpled and broken and with a dip of about 70°. The rocks on each side of the lens are Huronian looking schist, green and chloritic, or pale

yellowish gray sericite schist; in the latter case apparently sheared quartz porphyry. Part of the green schist is agglomerate, with boulders greatly tailed out. The pale sericite schist if decayed is spoken of as "soap rock," and when impregnated with iron oxide so as to have a red color is "paint rock." Miners expect to find soap rock on each side of the jasper and ore. It is suggestive that soap and paint rocks, precisely like those of Tower or of the Jackson mine, occur at the southeastern edge of the Helen mine at Michipicoton. The ore body at the Tower mine is 50 to 150 feet wide, with some "horses" of jasper, and it has been followed down to 1000 feet, the workings extending down to 850 feet. The ore is mostly of the "hard blue" kind of hematite, and averages about 67 per cent iron, but is a little high in phosphorus. The mine needs no timbering, since its walls are so firm. It ships about 450,000 tons per annum.

An examination of the hill shows that frequently, instead of red jasper interbanded with the steel gray iron ore, a black variety like chert or gray, or pale greenish varieties of silica occur, some of them much like specimens obtained from the Michipicoton region.

A hill at the town of Tower shows a broad exposure of chlorite schist and jasper, the latter in quite irregular bodies or lenses, sometimes forming almost a giant breccia with the schist. Here two openings have been made, disclosing good ore, but the amount present has not been determined. Descriptions of the arrangement of the country rocks and ore bodies at the Chandler and Tower mines may be found in the Iron Ores of Minnesota, by Winchell.[9] This report states that "the mined iron masses have no regular manner of alternation or position in the strata of the Keewatin. They appear suddenly and irregularly. They have no constant hanging wall nor foot wall. They cannot be followed along the strike for great distances. The largest jasper-ore masses are traceable not more than a mile and a half."[10]

A short visit was made to the Biwabik mine on the Mesabi iron range. The Mesabi ore bodies are of quite a different kind from those of the Vermilion, and belong to a different horizon, according to Mr. Spurr of the Minnesota Geological Survey being Animikie or Upper Huronian, which extends to the northeast into Ontario in the neighborhood of Thunder bay.[11] As in Ontario, these rocks have usually only a gentle dip, about 10 or 15 degrees, and rest upon the upturned edges of the Keewatin schists or the Laurentian, and Canadian geologists generally look on them as later than Upper Huronian in age, possibly Cambrian.

On the Mesabi range the Animikie is divided into three chief members, the basal quartzite, the iron-bearing member, and the upper slates. The iron-bearing member of the series, the only one which need be further described, is about 800 feet thick and is very variable in character, sometimes cherty or jaspery, sometimes earthy slates, and is of various colors, such as brown, red or green; but all merging into one another The iron ore associated with them is also variable, including magnetite, hematite and limonite. As in the Vermilion range, the ore bodies seem to result from the concentration of iron disseminated through the rock as a whole, in certain parts, where impervious basins give a chance for this; but the Mesabi ore deposits are usually shallow and flat, instead of being lenses running parallel to the dip, as at Ely or Tower. Spurr thinks the source of the iron is to be found in marine glauconite deposits, like some now being formed, and that organisms have played a part in the work. Afterwards percolating surface waters decomposed the glauconite, forming silica and iron oxide, the latter being concentrated in regions of greatest oxidation.[12] He thinks that the iron bearing member of the Mesabi is confined to Minnesota, and does not extend into Ontario, but no very good reason is given for this view.

At the Biwabik mine, near the town of the same name, two large open cuts about 150 feet deep and covering many acres give a good opportunity to study the deposits. About 50 feet of stony till overlie the ore, and must be removed before mining can go on. This work is done with a steam shovel and narrow gauge railway, the clay being heaped in great hills to one side of the mine. Below the clay is a bed of red paint rock, looking like ore but low in iron, then bands of brown hematite and yellow ocher, alternating with

[9] Bulletin vi, Minn. Geol. Sur., 1891, pp. 47, etc., and 177, etc.

[10] Ibid., p. 61.

[11] The Mesabi Iron-bearing Rocks: Spurr, Bull. x, Minn. Geol. Sur., 1894, p. 4.

[12] Ibid., p. 259.

blue ore, which is of the best quality. There are a few white sandy layers, residual silica after the leaching out of the iron compounds, according to Spurr. Most of the ore is soft, but some is hard, and both hematite and limonite are mined; the whole it is said, averaging 60-65 per cent, and reaching Bessemer grade. No jasper was seen, though some of the blue ore is hard enough to scratch steel. The ore is evidently stratified, and has a dip of about 20° away from a rocky hill behind the mine. All the mining is done with steam shovels, the ore being dumped into cars, which when loaded are taken directly to the shipping port. Though the mine is not a very large one for the Mesabi region, it ships about 450,000 tons per annum. The nearest rock, which forms the hill in the rear, consists of grayish graywacke conglomerate; but the thick beds of boulder clay prevent a study of the immediate country rock of the mine.

While the Mesabi mines, where millions of tons of ore are handled with steam shovels only a very few miners being required, are unique in the world, and thus far have no parallel in Ontario, it is too soon to say that no parallel will be found in our Animikie. That impure carbonate ores form considerable beds near Port Arthur, and that immense deposits of hematite occur near the Mattawin river, is certain. The latter ore deposits contain much jasper in some places, and are more steeply tilted than most of the Mesabi rocks, but they seem to correspond better, in some respects, to the conditions of the Mesabi range than to those of the Vermilion. As most of the Mesabi deposits are in low ground, covered with drift and difficult to find, it may be that similar beds remain to be discovered in the Mattawin region. The slaty red hematites of the Mattawin range occur in hills, evidently being harder than some of the adjoining rocks, unlike the Mesabi ore bodies, and the ore also is considerably lower in iron. If deposits should be found in the valleys we may expect them to be more highly concentrated, and therefore richer.

THE MICHIPICOTON IRON RANGE.

While waiting at the Sault Ste. Marie for transportation to Michipicoton Post a visit was made to the pulp mills, where Mr. Sjoestedt showed us his metallurgical plant for the treatment of nickel ores. The ore with which he was experimenting comes from a mine controlled by the Clergues, between Sudbury and Worthington, and is pyrrhotite almost completely free from copper pyrites, something unusual in the Sudbury district. His process requires ore free from copper, so that any bits containing copper pyrite are picked out, and less than $\frac{1}{10}$ per cent. is found in the material treated. The ore is roasted sweet in a furnace arranged for this purpose, and also to supply sulphur dioxide for the manufacture of sulphite pulp. The thoroughly roasted ore is smelted in electric furnaces, having a capacity of about one ton per day, the metal resulting being ferro-nickel suitable for alloying with steel in the manufacture of nickel steel. The ferro-nickel contains about 6 per cent. of the latter metal. This process was devised in the first place to supply sulphurous compounds for the projected paper mill; but as carried out the whole of the ore is utilized, unlike the method adopted by the Canadian Copper Company, where the sulphurous gases are poured into the air in the process of heap roasting, destroying the vegetation for a mile around, and the iron is largely removed as slag in the furnace, while the matte resulting still requires an elaborate treatment before the refined nickel and copper are produced. If Sjoested's method is successful, and it is stated to work well on the scale now used, it should form a great advance in the treatment of our nickel ores. Unfortunately, most of our ores are largely mixed with copper pyrites, and so not adapted for the process. Possibly a method of magnetic separation of the magnetic pyrites from the non-magnetic copper ore might be adopted for the ordinary Sudbury ores.

The production of ferro nickel suggests the further advance to nickel steel, and so the need for pure ores to supply the necessary iron. Such ores are found in the Helen mine, owned by the Clergues' company.

By the kindness of Mr. Clergue we were invited to occupy berths on his steam yacht, and thus saved some time in reaching Michipicoton. Landing at little Gros Cap, we rowed round the cape to the iron mine worked years ago. As it has been described in a previous report [13] and also by Mr. Macfarlane in a report of the Geological Survey [14]

[13] Bur. Mines, 1899, p. 145; also p. 254.

[14] Geol. Sur. Can. 1863-66, pp. 130-1.

it will not be necessary to devote much time to it here. As far as the mine itself is concerned, there is less to be seen than when Macfarlane visited it 35 years ago. He states that in the main shaft the ore was steadily improving, and Capt. Grierson, who had charge of the work, states the same; so that further work on the property may be desirable. The associated rock is called quartzite by Macfarlane, but much of it resembles rather chert or very fine grained sandstone. Four or five feet of this rock with little iron ore form the hanging wall of the deposit, but the rest consists of thin bands of chert or sandstone, and hematite. Massive looking agglomerate forms the adjacent rock to the west, while that to the east is soft, rather fissile, green gray schist. More or less interrupted bands of sandstone occur in the greenstone farther east. The general association resembles that of the Vermllion range, but without the jasper so characteristic there. Between this and the Helen mine, ten miles to the northeast, the band of iron-bearing rock has not been found. On Gros Cap it runs out into the lake at each end, and has not been observed on the main shore.

THE HELEN MINE.

The Helen mine, at the east end of the pond called Boyer lake, is much more promising and of a quite different nature. At the time of our visit a very rough trail from Wawa lake was the only means of access to the mine, and little work beyond stripping had been done. At present the railway from the harbor at Gros Cap is nearly completed, and will soon afford ready communication. Lake Boyer, which is about $\frac{1}{4}$ mile in length and half as broad, and 650 feet above lake Superior, forms the first of a chain of small lakes flowing into Magpie river. The region is very rugged and hilly, rising almost to a mountain just east of the lake, the highest point being as determined by Mr. Clergue's engineers 443 feet above its level and 1,093 feet above lake Superior, or 1,694 above sea. The depth of this small body of water is said to be 150 feet, but Capt. Williams, in charge of the mine, had sounded near the ore body at the east end and had found only 115 feet. It empties by a little stream having a fall of 26 feet over solid rock into the second pond, Sayers lake, still smaller than Boyer lake, but said to be equally deep; and this lake sends a stream over solid rock also with a considerable fall into the next lake. It is probable that the hollowing of these two lakes out of the rock has some connection with the formation of the ore deposit.

The ore body rises as a point from the east end of Boyer lake, and forms a hill 94 feet above its level at the highest point, from which it sinks in all directions. On July 19 stripping showed that the ore body was at least 450 feet in length from east to west, and 350 in breadth from north to south. As good ore could be seen to extend below the water, the thickness was evidently greater than 90 feet. Since then, as I am informed, on March 21, by the kindness of Mr. F. H. Clergue, the superficial area has been proved to be 650 by 850 feet, and the diamond drill has shown that the ore goes to a distance of at least 188 feet below lake level. An average of analyses of the ore showed 64 p. c. metallic iron, 0.025 sulphur, and 0.045 of phosphorus. It was expected at that time that the ore dock would be ready for shipping on June 1, and that a crushing plant of the capacity of 5,000 tons per day would be in operation on May 1.

The ore on the surface is chiefly hard, somewhat porous limonite; but parts of it are "blue" (steel gray), or have the yellow of ocher, and other parts the red of hematite, so that different varieties are mixed. However the average contents of metallic iron are much above that of limonite, so that most of the ore must be hematite. The ore has sometimes a brecciated look, and often shows grape-like or botryoidal concretionary layers. On the north side some fragments of decayed sandstone occur, cemented by ore and in the ore itself in a few places glassy quartz grains are seen. No pyrites was observed however.

An open cut and short drift to the south of the ore body disclose boulder clay above and ore below, with soft pale schist at the end of the drift, the "soap rock" of the miners on the Vermilion range. The schist next the ore has been impregnated with red iron oxide, and is "paint rock."

A steep ridge of hills rises along the south side of Boyer and Sayers lakes consisting of various schists, first sheared felsite, then gray green schist, probably sheared porphyrite, the latter possibly a dike. On top of the ridge the rock is sheared porpyhry or felsite. All of these schists strike about east and west and have a nearly vertical dip.

North of the ore body one finds first 400 or 500 feet of sandstone and chert, interleaved with lean ore, mostly limonite, forming a vertical cliff. A little to the west of this is a breccia of chert, with hematite as cement. Going still further north there is a steep ridge or hill of green schist, with nearly vertical dip and a strike about east and west. For about one-eighth of a mile beyond, one finds steep parallel ridges of similar green schist, making a country very difficult to traverse.

At the outlet of Boyer lake the stream flows over what seems to be very pyritous sandstone, now black and deeply weathered. The next small lake flows over similar but more distinct sandstone, with pyrite and secondary iron ore, and the rocky wall to the west shows some ore. A tunnel runs into the hill on the southeast corner of this lake and discloses a great mass of finely granular impure pyrites. Here and there in the pyrites are fragments of sandstone, and there are some vertical cherty looking layers, as though the sandstone or chert was here filled with sulphide instead of oxide of iron.

At the west end of Sayers lake (the second in the series) the sandstone band appears to be about a fifth of a mile wide, but is broken near the middle by a band of green schist, with a little dark slate, the whole about 200 feet in width. Beyond Ely's camp at the west end of the lake a stream flows down a steep dam of pyritous rock toward the next lake. That each of these two deep little lakes should have a narrow dam of pyritous sandstone cannot be accidental. On the trail south of lake Wawa gray and brownish and green schists are crossed for at least a mile, when a large area of a coarse grained green eruptive, probably weathered diabase, is encountered. Beyond this, at the northeast corner of Wawa lake, is the singular conglomerate referred to in a former report. The ore-bearing sandstone has not been traced to any distance west of Sayers (or Glen) lake; so that it cannot be connected with certainty with the short band described before as crossing the end of little Gros Cap. It may be that the connecting link is buried under the old lake sands of the wide Magpie valley, which cover much of the intervening region.

Turning eastward from the Helen mine, a steep path leads up the hill, which rises 450 feet in a few hundred yards, and turns out to be a comparatively narrow ridge with an eastward trend for about $\frac{3}{4}$ of a mile, when it sinks precipitously to a wide valley. Several costean pits across this ridge give hints of its structure. Apparently the cause of the hill is to be found in a large dike or band of pale bluish gray felsite, exceedingly hard and resistent, forming its backbone.

On the surface this rock is commonly weathered for a few inches and covered with dark brown limonite, which had been taken for ore. Wherever the trenches penetrated the surface, however, the fresh rock appeared, and was always found to contain much iron pyrites, probably the source of the coating of brown iron ore. Parallel to this belt of eruptive rock, which shows no signs of schistose structure so far as seen, we have sandstone and various schists, all striking nearly east and west with nearly vertical dip. One section across the ridge shows the following succession of rocks from south to north:

Fifty yards of soft greenish schist with some quartz veins.
A few feet of greenish and yellowish brown schists.
A little sandstone.
Eighteen yards of felsite.
Eight yards of felsite and green schist.
Twenty-five yards of brown rock greatly weathered, partly schistose.
A considerable width of sandstone and chert banded with iron ore.

Owing to the wooded and rugged character of the hill top, the boundaries of the different bands of rock could not be definitely fixed, except on short stretches opened up by costean pits. The width of the summit of the hill is less than a quarter of a mile. Sections across in other places gave a similar result, though the different rocks seem to vary in thickness from point to point, and at one place somewhat farther west a band of conglomerate or breccia was found near the southern side of the ridge, the angular pebbles consisting chiefly of sandstone and felsite. Next to this on the south is soft yellowish felsite schist, and north of it sandstone. It is doubtful if the breccia is of sedimentary origin. At one point about 150 feet down the north side of the ridge Mr. Ely had commenced to drift into the banded sandstone. The material to be seen consisted of the sandstone interbanded with brown iron ore, and a seam of pure limonite running down through it. He expected to find a body of soft iron ore by means of this drift, but apparently failed in this, since the work has not been continued. So far as our

hasty examination goes, it appears as if the felsite had erupted through the soft sandstone, the greatest thickness being left on the north side.

Returning to the ore deposit at the east end of Boyer lake, it will be noted that its position is a very peculiar one. It forms a large mass at one end of a lake basin with an amphitheater of high hills enclosing it on the north, east and south, the walls rising very steeply on all sides, except towards the west, where the lake empties. The arrangement suggests the impervious troughs in which the ore bodies of the Vermilion and Marquette ranges occur; however, there are certain well marked differences from the American ore deposits. Usually they are more or less covered with banded jasper or chert; while here the corresponding banded chert and sandstone lies entirely to one side, and the ore body rises in a dome-like way, sloping down on all sides towards the hills enclosing it, as if it had been heaped up on the bottom of the basin instead of having been produced by the slow replacement of sandstone by ore in the original position occupied by the rock.

A second theory is possible, that the body of ore has been formed by the oxidation of pyrites from the sandstones and other rocks around. In this case the pyritous sandstone at the lower end of each of the two small lakes may have provided the iron, and in its decay the hollows of their basins may have been produced. Until mining shall have disclosed the true relations of the ore body to the surrounding rocks, it may be impossible to decide which theory is the correct one. Some features point towards the theory of replacement, e g., the fragments of sandstone in the ore toward the north side and the occurrence of paint rock and soap rock on the south side; while others fit better with the theory that the deposit was made in an open basin by surface waters. The fact that the ore is largely porous limonite, the arrangement and shape of the ore body, and the fact that it is not covered by any capping of rock, seem to favor the second. Possibly both methods may have been in operation at different times. In any case exploration up to the present shows that millions of tons of excellent ore have resulted, so that the mine bids fair to compare favorably with those of the States south and west of lake Superior. It is possible that the Helen mine has more analogy with the Mesabi than with the Vermilion range, but the rocks enclosing it have all the appearance of Lower Huronian or Keewatin, and not those of the Upper Huronian or Animikie.

THE RANGE TO THE EAST OF HELEN MINE.

As the next point where the iron bearing sandstone had been found was some miles away, near Eleanor lake, we returned to Wawa and set out eastward with canoes. By aneroid we found Wawa lake to be 303 feet lower than Boyer lake, or 347 feet above lake Superior. Our estimate from several aneroid readings the previous summer was 352 feet for Wawa lake, but the results of levels carried out by the railway engineers give a considerably lower elevation, 337.6 feet, and this must be accepted as accurate. Last year's readings should therefore be lowered by about 14 feet.

A short distance south of Eleanor lake, and more than two miles northeast of the hill near the Helen mine, ferriferous sandstone is found again on one of the old Johnston locations; but the rock has not been observed between those two points As seen on the portage trail between Wawa and Eleanor lakes, the rock forms a steep cliff, the banded sandstone being about 100 yards wide, but not showing any good ore. It has the same appearance as that near Boyer lake, and is accompanied by the same rocks. On the hill top we found no felsite, though that rock appears on the face of the cliff, but sericitic or felsitic schist and greenish eruptions are seen on each side of the sandstone. At one place a little black carbonaceous shale occurs to the south of the schist. The felsite is much narrower than on the hill east of Boyer lake, but weathers with the same rusty surface, suggesting iron ore, and has the same pale gray surface with much pyrites on fresh pieces; no pyrites was seen in the sandstone, however.

The portage between the two lakes follows the old Grasett road, which is still in fair condition at most points, and runs west along the south shore of Eleanor lake, and then bends round its western end and turns north again. We walked about $3\frac{3}{4}$ miles along it to examine the rocks exposed. South of Eleanor lake fissile black slate may be seen, but on bending round the lake to the north, only gray green schist and schist conglomerate or agglomerate, with many variations in strike, was found.

Portaging a mile northeast from a small bay of Eleanor lake, we reached a pond and made another short portage into Loon-skin lake, which we mapped. The lake trends

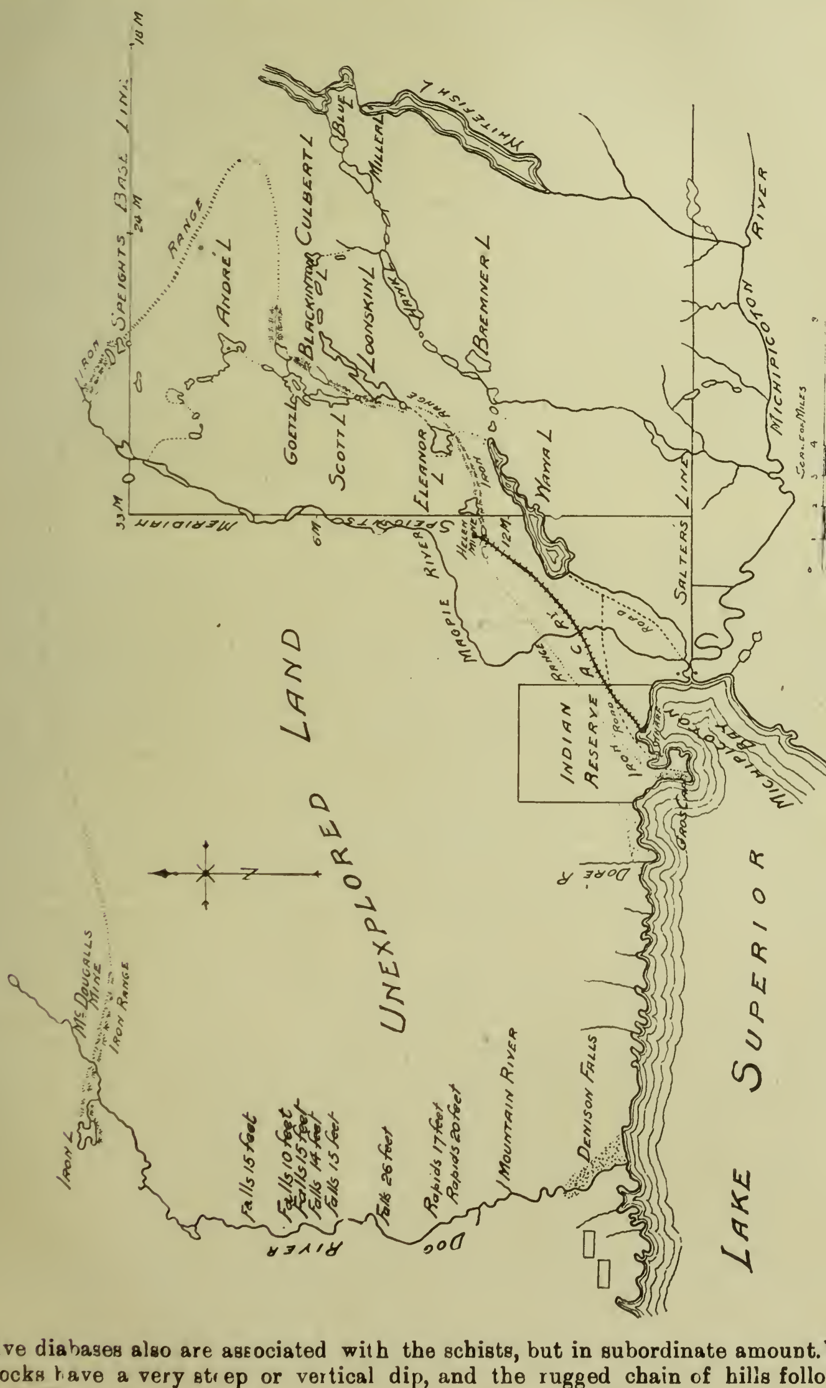
northeast and southwest, has a length of three miles, and is greatly cut up by bays and narrow shallow channels. The rocks observed were all green Huronian, not very schistose. As the portages proved to be very bad, especially for our large Peterboro' canoes, we left most of our stuff at the northeast end of Loon-skin lake, and with one canoe and a light outfit made our way northward to Magpie river. The canoe was rather crowded for four, including our two Indians and ourselves, but served the purpose on the chain of small lakes and rivers we had to traverse. On the numerous portages, often with no path to be found, we carried everything at one load and thus saved much time. As the region had never been mapped, we carried on a track survey with prismatic compass and time allowance. Turning north from the northeastern corner of the larger expansion of Loon-skin lake, two short portages, with a pond between, lead into a small body of water which we named Scott lake, from a gentleman who had suggested this route towards the north. From this lake, which is a mile in length, there is a short portage to the next sheet of water, which we named Goetz lake, from a prospector who had staked claims on its shores. At the southern end of Scott lake there is a hill on which about 150 feet of banded sandstone occurs, with a strike of 75° or 80° and vertical dip. Some of the rock is cherty and reddish, but no good iron ore was to be seen. To the north there is greenish schistose rock. Goetz lake, which is about a mile in length from southwest to northeast, and is divided centrally by a long narrow island having the same trend, shows in general only Huronian schists and eruptives, but the band of iron-bearing sandstone seen on Scott lake runs about parallel to it and is only a quarter of a mile from its eastern corner. Here we found that a number of claims had been staked by Alois Goetz. On No. 2 claim there is black chert in thick beds, while on the south side of a small body of water called Parks lake much red hematite is found in loose blocks, and near by Prof. Willmott has observed red hematite in place. Some of this ore seems to be of excellent quality, but the size of the ore body has not yet been determined. Boulders of limonite were seen at other points of the claims, but the thick moss and the forest covering prevented any careful study of the outcrops, as no stripping had been done. Black slate with a strike of 40° occurs not far off, and at the west end of Parks lake green schist is found, having a strike of from 40° to 60°.

A short portage, followed by a marshy pond, and then a long portage, lead northeast from the upper end of Goetz lake to André lake, a mile and a half away. At the southern end of the pond there is a band of schist conglomerate about 200 yards wide, with well-rounded pebbles of quartz porphyry, felsite and probably sandstone, and with a strike of about 80°. This is half a mile northwest of Parks lake, where the banded sandstone is found.

On André lake only Huronian rocks of the ordinary kind were seen, and the same is true of the chain of small lakes and ponds which we followed toward the northwest. The third lake in the series is of considerable size, but we could not spare time to map its shores. Turning west from this there were three portages with small ponds between, leading over to a small narrow lake where J. H. Scott has taken up a claim. There is a conglomerate or breccia of pale green rock, containing fragments of quartz porphyry. The quartz to be seen is porous and rusty, but we found no gold, though free gold is said to have been obtained there. André has a claim to the west of this, but having little time we did not go to see it. From the small lake there is a portage of about a mile and three-quarters through untouched forest to Magpie river, here expanded so as to appear like a lake. We now canoed up the Magpie for two miles, and then a short distance up a tributary creek, coming in from the northeast. From here we walked to a small lake 2½ miles to the southeast.

Soon after striking inland there was a series of rugged hills, on whose bare surfaces interbanded sandstone and magnetite were to be seen, with a general strike of 100° to 130°. Some of the bands are purple, and approach jasper in character. The banded siliceous rock is often contorted and faulted, and sometimes mixed with sericitic schist. The part highly charged with iron varies in width, 7 yards being about the maximum, but rusty bands more or less parallel to one another occur in places across a space of 80 yards, though only a small part of this can be called ore. Probably all of the ore is too much mixed with sandy granules to be of value. Some vein-like bands near the shore of the lake contain pyrite, but this mineral was not seen elsewhere.

The accompanying rocks are sericitic and chloritic schists, often with a structure like sheared agglomerate. In one such schist the boulders, much drawn out, are pale in color and pitted, while the green basis, present in small quantities, shows no pitting. At one point near the lake there is an outcrop of fine grained granite cutting the schist. Some



Plan showing the Iron Range in Michipicoton Mining Division.

massive diabases also are associated with the schists, but in subordinate amount. All of the rocks have a very steep or vertical dip, and the rugged chain of hills follows their strike. The region has been very thoroughly burnt over, so that exploration is unusually

easy. We did not attempt to follow the sandstones beyond the small lake, but returned the way we came. Most of this range of hills had been staked out as claims by the Messrs. Ganley. None of the ore seen by us is of promising quality, but the diamond drill may disclose ore bodies at some depth below the surface, as in the Vermilion region.

The small lake is about 5 miles north of Parks lake, referred to before, where claims had been staked on similar sandstone with hematite. As the band of iron bearing rock was there running about east, it must make a sharp turn in the meantime, but the intervening portion had not been explored at the time of our examination.

We now ran down the Magpie river, portaged over to Wawa city and retraced our route to the northeastern end of Loon-skin lake, where the second canoe and our main camp had been left. From this point we advanced eastwards with the two canoes for two miles and a half to Cuthbert lake, the route being a very bad one over shallow ponds and along creeks so small that most of the way we had to portage. Cuthbert lake is within the Laurentian, but in this part of the region there are few exposures of rock. From this point we made a portage ¾ of a mile south, over level sand plains to McVeigh's creek, a very crooked stream in most parts, emptying into the northeast end of Hawk lake. From this point we followed the usual canoe route via Manitowick lake to Missanabie station on the Canadian Pacific. Near the north end of Manitowick were encamped two prospectors who believed they had found the iron range about 7 miles to the west, not far from Jackfish lake. They had probably struck the range near its bend toward the northwest. They reported that the ore was brown, and that they saw no jasper or sandstone. As they were uncommunicative regarding the route to their find, and no trails had been cut, we decided not to waste time on a search for the deposit.

IRON RANGE NEAR DOG RIVER.

Going by train from Missanabie to White river we made arrangements to visit Mr. W. H. McDougall's iron claims near Dog river. As the canoe route from White river to the point on Dog river where one turns off to the iron locations has been described by Prof. Willmott in a previous report,[15] no further reference need be made to it here. On our way toward the iron deposits we met a party of Minnesota men under Mr. James on their way out after examining one of the claims. They spoke of the iron range as very similar to the Vermilion range, but reported no large deposits of ore in sight, and thought much work might be necessary to develope the region, the best method being by test pits sunk in the low ground.

Iron ores have been found on Iron lake and on Paint lake, the former to the west of Dog river, the latter to the east. To reach Iron lake one turns off a little below Paint creek, making a portage of nearly three miles over sandy plains with open woods to the eastern end of the lake The portage is broken by two small ponds and a short stretch of navigation on a very crooked creek. Iron lake is nearly three miles long, trends east and west, and is divided down the middle by a very steep rocky ridge, broken about midway with a strait joining the two parts of the lake, which is shaped somewhat like a capital H. This rocky ridge consists mainly of black chert and jasper, interbedded with thin seams of magnetite. The band of siliceous rock is at one point at least 37 yards wide, and may be 30 yards wider, since part of the surface is covered. The top of the hill suggests strongly the hill top showing jasper and iron ore near Tower, but here no bodies of hematite are to be seen. The strike of the band is about 80° and dip from 80° to 90°. The range was followed for about a mile to the west of the strait, and probably extends farther west. The continuation of the ridge to the east of the strait is said to consist largely of the same rock, but we had not time to examine it. The rock along the foot of the cliff is brown schist.

The route into Paint lake starts about three miles up Dog river, near Heart mountain, and runs southeast for 2½ miles over an exceedingly rough trail through densely wooded swamps and up steep rocky hills. Paint lake is small, with a muddy bottom, and the creek flowing out of it is too shallow and crooked for canoe navigation. The usual sandstone crops out near Paint lake, but is accompanied by great masses of magnetite, unlike the thinly banded association of sandstone or chert and iron ore. The masses of magnetite

15 Ont. Bur. Mines Rep., 1898, p. 140.

contain bands and fragments of sandstone, are very far from being pure ore, and in most places there are many scattered crystals of pyrite, a quite unusual circumstance in other parts of the range. The ore body strikes east and west, and at one place is 100 feet wide, if not more, but with some bands of rock intervening. On the north shore of Paint lake is a deposit of limonite and yellow ocher, from which the name is derived, stretching for about 200 feet, but nowhere very wide and apparently not more than three feet in thickness. Sandstone filled with pyrite, like that at the foot of Boyer and Sayers lakes near the Helen mine, is to be seen cropping out at one or two points on the shore, suggesting that the limonite may have originated in the weathering of pyrite. The magnetite of Paint lake would probably require magnetic separation and roasting to make it of value, and even then would be low grade, since the intermixed particles of magnetite and silica are very fine and hard to separate.

Close to the large mass of impure magnetite there are great veins and irregular masses of white quartz associated with granite, taken up by Mr. McDougall as a gold claim, but of unpromising appearance.

Professor Willmott, who has examined the region a second time since our visit, reports two or three outcrops of sandstone between Iron and Paint lakes, so that they no doubt belong to a continuous belt, but finds that the rock turns north at the latter lake, near the mass of magnetite. There are two other outcrops within a mile to the north, and an iron range a mile in length 5 miles to the east. Apparently the band of iron-bearing sandstone has been thrown into a complex fold with a nearly vertical pitch, or else faulting has taken place on a large scale.

Schist conglomerate is to be seen at several points on Dog river, somewhat northeast of where the iron range is supposed to cross it.

It is probable that the more or less continuous belt of iron bearing rock just described is in reality connected with the belt previously described on the east of Magpie river, but until the stretch of about 10 miles which separates them has been explored this cannot be stated with certainty.

If all the outcrops described, from little Gros Cap to Iron lake, belong to the same band or range, its length is at least 60 miles. Out of this length about 25 miles have been followed up with no gaps greater than a mile or two, and it is entirely probable that careful prospecting will show that the range is continuous. Whether it extends to the west of Iron lake is uncertain, but it may be expected to continue to the end of the area of Huronian schist which it accompanies, and this ends before reaching the watershed between the Bremner and Pucaswa rivers, about 20 miles to the west.

Very similar sandstone associated with iron ore occurs on Pic river, particularly resembling the deposit at Paint lake, and has been briefly described by Prof. Willmott in last year's report.[16] This is about 55 miles to the northwest of Iron lake and separated from it by a wide band of Laurentian, so that no connection can exist between them. Very little prospecting has been done near Pic river, and the extent of the range in that region is unknown.

SILICEOUS IRON ORES OF BATCHAWANA BAY.

It is probable that siliceous iron deposits of a similar kind exist at other points near the shore of lake Superior. A specimen of banded quartzite from cape Choyye, about 24 miles south of Gros Cap, mentioned by Mr. W. F. Ferrier as included in the petrographical collection sent to the Chicago Exposition in 1893, possibly represents a continuation of the band at Gros Cap ; and the deposits north of Batchawana bay about 65 miles from the same point seem to be of a similar character. Mr. Macfarlane says of them that "the Bachewanuing ore is situated about 7 miles northwest of the village of that name. The rocks in the neighborhood are diabase, diabase schist, greenstone and greenstone slate, and the latter rock forms the side rock of the deposit. The strike of the orebed is parallel with that of the enclosing rocks, but its exact direction is difficult to ascertain, as the ore exerts some influence on the needle. It is however about east and west, or a little south of east and north of west. The dip is about 80° to the northward. The ore is principally specular iron, the less compact hematite being comparatively rare. The

[16] Bur. Mines Rep., 1898, p. 257.

specular iron contains an admixture of magnetite, as some of it is attracted by the magnet. Both ores in fine-grained narrow bands are interbedded with similar bands of dark red jasper, and the direction of these bands is parallel with that of the ore bed. This jasper is so plentiful that it becomes a matter of difficulty to obtain a piece of perfectly pure ore of a moderate size, say from 8 to 12 inches in diameter. Although the banded structure is often beautifully regular, it is sometimes found winding and contorted. Minute veins of quartz cross the bands very frequently, and grains of the same mineral are intermixed with the jasper. Iron pyrites also occurs occasionally. The thickness of the bed thus composed is not less than 20 feet, and in some places cannot be less than 40. Many openings have been made at different points on the length of the bed, but nowhere could I observe ore resembling in solidity and richness that of Marquette. Since however at the Jackson and others of the celebrated south shore mines such banded mixtures of ore and jasper are of frequent occurence, it is not unreasonable to expect that richer masses may yet be found in or around the Bachewanuing mine. So far however as the ore at present in sight is concerned, it does not seem possible to excavate any large quantity of it exceeding in richness 30 or 40 per cent." [17]

Another account of siliceous iron deposits near Batchawana bay has been given by Mr. J. A. Holmes, state geologist of North Carolina, who examined the region in 1899 for Mr. George C. Heck, of Raleigh, N. C. Thanks are due to Mr. Holmes and Mrs. Heck for their courtesy in allowing me to make use of the information thus obtained. Mr. Holmes "landed near the mouth of Carp river and proceeded on a nearly direct northerly course for the first few miles, following the road bed of the old Batchewaning Iron Company's railway, and beyond that point following a hunter's trail. About 9 miles north of Batchawana bay he found and examined several iron ore deposits which were said by the Indian guide to have been located by Hugh Wilson." The mineral lands are situated about 9 miles east of Pancake bay, and include the Mammoth Iron Mountain location, the Vulcan location, and two other locations. The ore bodies were first described in 1866 by a land surveyor, Mr. Hugh Wilson, and Prof. Robert Bell of Queen's University, now Dr. Bell of the Geological Survey, Ottawa They speak of a half acre of iron ore surface exposed on a glaciated portion of the Mammoth location, and state that "the ore consists of layers of compact and sometimes crystalline magnetic iron, alternating with others of siliceous slate and quartzose rock, each varying from $\frac{1}{8}$ of an inch to one inch in thickness, the average being half an inch. The slate and quartzose layers generally contain a good deal of iron, sufficient to make them magnetic, but in some cases the quartzose bands are granular upon the surface, and almost free from iron. In some places the seams of pure iron ore form more than half the whole rock, while in others the poorer layers predominate. On the average each variety may be said to form half the mass. The ore is strongly magnetic, and the fragments always exhibit polarity. The ore was traced over an area which was estimated on the ground to measure 50 by 30 chains, and therefore equal to 150 acres, making every allowance it would certainly occupy half that extent. Owing to the contortion and corrugation in the strata, as well as the interruptions caused by the greenstone dikes, it was impossible to estimate the total thickness of the ore, which is probably very great, but I may mention that on the shore of the pond at the northwest corner of the location I saw a clear section of 40 feet across the beds, allowing for contortion, etc., and at the east end of the mountain another of 70 feet." Prof. Bell also gives the analysis of what he considers an average sample of the ore which showed 47.9 per cent. metallic iron.

Concerning his own examination, Mr. Holmes says that the conditions were sufficiently unfavorable to make the results in a measure unsatisfactory, as he was unable to determine the exact position of the locations, so many of the boundary posts had disappeared. On what he supposed to be the locations, he found several outcrops of ore of the character described by Wilson and Bell. Near a pond he found an outcrop exposed for 35 feet, at right angles to the dip, the country rock in the vicinity being rather fine grained compact diabase. To the east of this ore bed for several hundred yards both diabase and gneissic rocks were exposed at intervals.

About a half-mile east of ore bed No. 1 he found a similar ore bed, but more siliceous, striking nearly east and west and dipping 45° to 50° to the south. About 200 or

[17] Geol. Sur. Can., 1866, p. 130.

300 yards north of this, and probably 150 or 200 feet above it, ore bed No. 3 was found on a small mountain knob. Its thickness as far as exposed was 15 feet. Ore bed No. 4, supposed to be still on Mammoth Iron Mountain, was about a third to a fourth of a mile north of ore bed No. 3, and occupied a small knob hardly more than 20 by 50 feet across the top. No less than 20 feet of ore occur here, striking about east-northeast and dipping 30° to 40° to the south-southeast. Loose fragments of ore were found between these exposures

"Samples of ore for analysis were collected with considerable care at the ore beds No. 1, 2, 3, 4 and 5, as described above, No. 5 being really the north of the outcrop of which No. 1 is the south end, the two being 75 yards apart. The result of the analyses showed:

Metallic iron, at outcrop No. 1	45.76
" " 2	29.77
" " 3	32.63

	No. 4.	No. 5.
Metallic iron	40 30	38 36
Silica	42 63	43.49
Sulphur	0.0103	0.0137
Phosphorus	0.097	0.028
Managanese	0.10	0 11
Titanium	None.	None.

These analyses were made by Dr. Charles Baskerville, Associate Professor of Chemistry in the University of North Carolina, who has for a number of years made the analyses of iron ores for the State Geological Survey. The structure of the ore at these various ore beds being laminated and the iron being magnetic, and being in a large measure separated from the siliceous material into laminæ, in which it is fairly free from silica, the per cent. of metallic iron in the ore might be greatly increased by crushing and magnetic separation."

As to the amount of ore to be found in the Mammoth Iron tract, Mr. Holmes believes that it is quite large, but no reliable estimate could be made without a much more thorough examination of the region than he could give

These two accounts probably refer to different parts of the same band of iron-bearing rock, since Mr. Macfarlane describes the ore which he saw as largely hematite and interbedded with dark red jasper; while Mr. Holmes and the earlier explorers of the Iron Mountain location mention neither jasper nor hematite. In Mr. Macfarlane's report the dip is put at 80°, while in Mr. Holmes' it is 30° to 40°. Evidently there is a large band of ore from seven to nine miles north of Batchawana bay, running in places east and west and elsewhere north-northeast and south southwest. The ore is not high in iron, but is low in injurious impurities, and, as suggested by Mr. Holmes, is well adapted for magnetic concentration. No bodies of soft ore have been found in the region, but no diamond drilling nor exploration with test pits has been carried out, so that it is not impossible that such may be found in the future. From the descriptions quoted above it is clear that the band of siliceous rock closely resembles those of Michipicoton and the States south and west of lake Superior, which is apparently more or less completely surrounded with a belt of iron-bearing rocks of Huronian age, just as it is surrounded by copper-bearing rocks of Keweenawan age.

That iron bearing rocks with important deposits of ore, both magnetic and hematite, occur west of lake Superior, associated with jasper bands on the Mattawin river and with hornblende schist on Greenwater lake, much like the gruenerite schist in the Marquette region south of lake Superior, has been shown in a former report.[18] As no further work has been done on the iron formation west of Superior, it will be sufficient to state that the Vermilion range of Minnesota passes into Ontario, and in all probability will be found to contain ore deposits of importance when carefully explored, since the accompanying rocks and the general attitude of the series are the same on both sides of the boundary.

GENERAL CONCLUSIONS.

With the rapidly increasing demand for steel in all parts of the world we may expect that prices of iron ore will continue at a profitable level, so that any deposits of good

[18] Ont. Bur. Mines Rep., 1895, pp. 81, 82 and 130-132.

quality and fair size will prove valuable assets of the Province; particularly if the steel and other industries resulting from the exploitation of our ores are carried on at home, as there now seems reason to hope will be the case.

While only one deposit, that of the Helen mine, has yet been found to be on a scale comparable to the great mines of Minnesota or Michigan, some of which have produced millions of tons of high grade ore, it must be remembered that the Michipicoton iron range has only been prospected for about a year, that it is in a region almost inaccessible except by canoe, and that up to the present practically no work in the way of diamond drilling or test pits in the low ground has been carried out, except at that mine. Many important mines have been discovered in this way in the States to the south and west, and there is a fair probability that equally good mines will be found in the extensive iron range already traced in Ontario.

It is doubtful if the well-known Atik-okan iron range, still farther to the west, is to be looked on as belonging to the same series of rocks, though it too is mapped as Keewatin or Huronian by the Geological Survey. Its ore is wholly magnetic, accompanied by green chloritic and hornblendic schist, and apparently without bands of jasper or sandstone. In fact it never shows the banded character of the typical iron-range rocks, but occurs as large lenses, 50 or more feet wide, more or less blending into the schistose country rocks. Here also there are ore bodies of very great magnitude, soon to be opened up by the Rainy River railway, and it is probable that these hard magnetites will require some of the softer hematites or limonites of the Michipicoton range to make a favorable mixture for fluxing.

From the brief introductory summary of the conclusions reached by the geologists who have studied the American iron ranges, it will be seen that all the important bodies of iron ore are of secondary origin, the original rock being a low grade ore, a slate with carbonate of iron or a hornblende schist charged with oxide of iron, or the peculiar banded rock so often referred to in the foregoing report. By a process of solution and concentration of the ore in troughs of impervious material, especially where eruptive dikes cut the rocks of the iron range, the immense and wonderfully pure ore deposits have been formed. It is evident that similar structural features will be the most favorable in our iron ranges also; and the only mine at all carefully explored illustrates this, since its ore body lies in a basin or trough walled on two sides by impervious schists, really sheared eruptive rocks, and on a third by a great dike of felsite. It appears also that owing to their mode of formation the ore bodies are more apt to occur at the lowest points of the range than on the ridges of a hard cherty or jaspery character. Up to the present nearly all the prospecting has been confined to the projecting ridges, a very natural state of affairs where the lower parts of the range are covered with thick layers of drift and hidden by mossy woods. In most parts of the region it will probably be necessary to sink test pits in the low ground in order to find the bodies of ore; and this of course is likely to be a slow and somewhat expensive process.

PARRY SOUND COPPER REGION.

On August 17 I went to Parry Sound, under the instructions of the Director of the Bureau of Mines, and found that much interest was being manifested in the copper deposits of the region, mining engineers from various parts of America and even from the Old World arriving by almost every steamer to enquire into their value. No doubt the rapid rise in the price of copper had directed the attention of capitalists toward this metal, and had stimulated the search for new deposits. Under the charge of Mr. Robert Forbes, manager of the Parry Sound Copper Mining Company, of Mr. Koren, superintendent of mines, and of Dr. Elftman, superintendent of reduction works, these engineers were shown the workings of the two properties most fully developed, the McGown and Wilcox mines. My thanks also are due to these gentlemen, especially Dr. Elftman, for their courtesy in serving as guides to the mines, in permitting me to make use of their steam yacht to visit some outlying points, and in providing information regarding the assays obtained from their ores and the results of the smelting of six car loads shipped to the Orford Copper Company for treatment.

In the summary report on this region published in last year's report a general account of the two chief mines was given,[19] and it will not be necessary to repeat the description; but a number of details of more or less interest were noted in addition to the main facts, and the more important points will be given here. By a reference to the former report it will be seen that on the McGown property, two miles east of Parry Sound, there were three openings, the first in order being an inclined shaft about 100 feet on the incline, the second an open pit 21 feet deep, and the third a vertical shaft between the two 9 by 11 in dimensions, and at that time 65 feet in depth. Earlier in the year six carloads of ore, in all weighing 143 tons, had been shipped to the Orford company, and the smelter returns showed that they contained an average of 15 to 16 per cent. copper, with some gold and silver. There were estimated to be 200 tons of selected ore on the stock pile, running from 25 to 30 per cent. copper; and 3000 tons supposed to contain from 8 to 10 per cent.

The ore which had been shipped came from the open quarry, about 50 by 25 feet in area, and most of the ore on the stock pile was from the same source.

Through the kindness of Dr. Elftman the results of a number of assays of ore and country rocks were placed at my disposal. The ore consisted chiefly of bornite, chalcocite and chalcopyrite, with some pyrite. Assays of chalcopyrite and bornite, mixed, yielded 39.9 to 50.6 per cent. copper. One sample of rock from the quarry contained nickel and arsenic. A piece of nearly solid bornite gave 70.4 copper, a very high percentage for this mineral. An average sample of ore from the southeast corner of the quarry containing some quartz with the copper minerals ran 22.7 per cent. copper, and another average sample 12 feet from the surface ran 25.5 per cent. The rock in which the quarry or open pit is excavated shows only a few stringers of quartz and no indications whatever of a vein, though there are small cavities and vughs in which a little garnet and dogtooth spar may be seen. The rock itself is a coarse gray diorite or norite schist, somewhat intersected by dikes of coarse pegmatite. Small amounts of copper ore occur in the latter rock, and some stripping has been done on a dike to the northeast of the pit.

The rock coming from the vertical shaft is of the same character, but contains much less copper. A sample of apparently barren rock gave 0.8 per cent. of copper; a hand sorted sample, representing about a third of the rock from the shaft, gave 10.5 per cent.; and an average of samples taken every two feet round the shaft at depths from 20 to 26 feet gave 3.1 per cent. of copper and half a dollar in gold.

The inclined shaft, which was started by the old McGown Mining Company when gold was the only metal looked for, produces rock which shows a good deal of copper, according to Dr. Elftman's assays, and a small quantity of gold, though no specimens of free gold are to be seen now, plentiful as they were in the earlier days of the mine.[20] At 15 feet from the surface samples of quartz ran 0.195 oz. in gold, a trace of silver and 4.8 per cent. copper; at 23 feet quartz with hornblende rock gave 0.19 oz of gold and 2.2 per cent. copper; and at 60 feet hornblende rock and quartz gave 0.25 oz. of gold and 6.5 per cent. of copper.

None of the ore bodies have definite outlines, and the deposit is probably caused by an impregnation or replacement of rock by ore, perhaps along a zone of fracture. The belt of rock showing more or less ore is about 250 feet wide at the east end, near McGown lake, widens to about 400 feet toward the west, and is about a 1000 feet in length.

There is not much doubt that the ore-bearing diorite schist is a sheared eruptive mass. Rock of a similar kind is widely spread in the neighborhood with many variations in strike, but generally having a nearly vertical dip.

West of the mine the character of the rock changes and the rocky hills of Parry Sound consist chiefly of fine grained white or flesh colored or gray gneiss, often excessively folded and contorted, and containing large "eyes" of black hornblende and of white felspar, often plagioclase. Some of the latter are two inches in diameter, are well rounded and seem enclosed by a finely crushed rim of the same materials. The gray gneiss sheets fold elaborately around these crystalline masses. These rocks as a whole suggest sediments, probably of pyroclastic (or volcanic) origin; and their microscopic characters will be discussed in the petrographical portion of this report. Pegmatite dikes ramify in all

[19] Bur. Mines Rep., pp. 259-261.

[20] Bur. Mines, 4th An. Rep. 1894, p. 98.

directions in some parts of the gray gneisses, and may account in part at least for the great amount of folding shown by them.

Among the most interesting rocks at Parry Sound are the crystalline limestones, which were studied somewhat carefully for a few days in the hope that they would provide a clue to the stratigraphical arrangement of the rocks of the region. A general account of the limestone bands of the region has been given by Dr. Bell.[21]

It was thought that if they were regularly interbedded with the schists the general relations of the schistose rocks might be made out by following the easily recognized band of limestone. In general these limestones are white, gray or flesh colored, coarsely crystalline, sometimes pure, but often containing darker grains of various silicates, and usually also fragments of adjoining schists, twisted and curled in an extraordinary way as if the limstone had torn them off like an eruptive.

The limestones near Parry Harbor were visited under the guidance of Mr. Adair, who observes such things carefully, and had already studied their distribution. Near Parry Harbor there are apparently two parallel bands of limestone, one with a strike of 55° to 60° and a dip of 25° to the southeast, and a quarter of a mile southwest of this another band with a strike of 65° or 70° and a very gentle dip to the northwest. The direction as well as the angle of dip is variable, and no outcrop can be followed more than a few hundred yards, though a succession of outcrops following the same general direction can be recognized. The thickness too is very irregular, being sometimes more than a 100 feet, and then rapidly thinning out till the bank is lost among other rocks. There is no distinct stratification, and we may suppose that any traces of bedding have been obliterated by the process of crystallization, or by the squeezing to which they have evidently been subjected. As limestone is the softest rock of the region, it has been forced to adapt itself to the forms of the other rock masses. The accompanying schistose rock, gray fine grained gneiss or hornblende schist, is always much contorted and crumpled, and the proximity of the limestone may be recognized in this way, as noticed by Mr. Adair. The various outcrops of limestone near the town, if continuous, would make one or two bands a mile and a half long, probably extending at least four miles to the northeast, since limestone occurs again on the shore and on an island of Mill lake. Whether it continues on in the same direction is uncertain, but several bands will be noted later suggesting this. A small outcrop of limestone is found also at Depot Harbor on Parry island, four miles west of Parry Harbor.

At Rose point, 2 or 3 miles to the south, where the Canada Atlantic railway crosses from the mainland to Parry island, one sees fine grained sandy looking gray gneiss very like that of Parry Sound, with the same eye-like masses of white felspar and black hornblende. At the railway station these ashy looking rocks are thrown into sharp folds with one gently dipping limb, then a sharp bend and a nearly vertical limb, the latter appearing to be to some extent a plane of shearing. Near by are bands of pegmatite of flesh color, mixed with the gray gneiss, and both faulted. On the railway a quarter of a mile east of this there appears to be a great fault, the gray schists being cut off by a coarsely spotted dioritic eruptive rock, now somewhat schistose by shearing. North of the hotel at Rose point there is a hill of rather coarse hornblende schist with many large garnets. The gray gneiss extends to the mouth of Seguin river, a mile southwest of the railway, and the general strike of the region is about 45° or 50°. Similar rocks with crumpled schists occur along the railway to the west until Depot Harbor is reached. On the southwest side of the Harbor there are extensive beds of very garnetiferous gneiss and muscovite mica schist, and also garnetiferous hornblende schist. On the beach near by parts of the sand and gravel are formed entirely of garnets, some an inch in diameter, but much checked, so that no very large clear pieces can be found. In a cutting near the dock banded fine gray gneiss and dark schist occur, having a strike of 75° and dip of 80° to the south. North of the harbor there are bare hills of fine grained yellowish gneiss with a strike of 60°, and dip of 50° to the southeast As one rounds the point on the way to Parry Sound the dip becomes very low, only 5° or 10°, and just round it the dip appears to be about 10° or 15° in the opposite direction, as if there were a gentle dome or anticline at the point.

It was a surprise to see a well appointed village of several hundred inhabitants, and a busy harbor with three steamers, each 300 feet long and of 17 feet draft lying in it, here

[21] Geol. Sur. Can., 1876-77, pp. 203-206.

in the midst of the woods on an Indian reserve. A large trade in grain and general freight is done here between Chicago and Duluth on the one side and the Atlantic steamers on the other ; all created within the last few years in what was a wilderness.

THE WILCOX MINE.

The Wilcox mine, owned by the Parry Sound Copper Mining Company, is situated in Cowper township 8 or 9 miles south of Parry Sound, but is best reached by steamer, which makes a circuit of 12 miles to the southwest and then round a peninsula to the head of a long bay. The ore body here is practically a fahlband, with no definite walls but merging into the gray garnetiferous gneiss of the region, and having a strike of about 60°, with a dip of 70° to the northwest. The main fahlband is at various points from 30 to 75 feet wide, as shown by the rusty surface of the rock, and may be traced without much doubt for about 1,000 feet. Half a mile to the northeast rusty rock shows again, and also at a mile and a half in the same direction. Whether they all belong to the same fahlband is of course far from certain. The Lafex mine, 7 miles northeast of the main shaft of the Wilcox, is considered to be on a continuation of the band. Much exploration will be required to prove this, however.

Besides the main fahlband there are smaller bands of rusty rock not far away, running parallel to it, all containing more or less copper pyrites. The main shaft, 9 by 11 feet in dimensions, was 22 feet deep on Aug. 25, and the rock on the dump formed a most singular ore. A coarse textured schist containing chiefly quartz, garnet, biotite and hornblende, is more or less filled with sulphides, especially iron and copper pyrites, the latter minerals sometimes scattered through it in a general way, sometimes running as small stringers. Apparently the presence of large hornblende crystals increases the amount of copper pyrites. Several other minerals occur in small amounts, such as bornite, zincblende, molybdenite and pyrrhotite. Dr. Elftman states that the average ore from the dump runs 4 per cent. copper, that two samples of copper pyrites yielded 20.5 per cent. copper, and that traces of nickel and of gold have been found.

As the Orford company intend, it is said, to establish a copper smelter somewhere on the Georgian bay, perhaps at Parry Sound, and will buy 4 per cent ore at current rates, less 30 cents per ton for transportation, the Wilcox mine should be profitable. From appearances at the time of my visit the ore is probably present in immense quantities, and there is no reason to suppose that the fahlband will not follow the schists down to considerable depths. The important point of course is as to the grade of the ore, which may require careful sorting or other treatment to bring it up to the requirements of a smelter. The appearance of the ore on the dump suggests that the particular band of schist had been shattered, and then infiltrated with iron- and copper-bearing solutions.

OTHER LOCATIONS NEAR GEORGIAN BAY.

The Lafex mine on lot 35, con. 9 of Foley township, about two miles south of Parry Sound, is owned by the Hattie Bell company and is supposed to be on a continuation of the Wilcox fahlband ; however, the character of the ore body and of the country rock are different. The ore consists of iron pyrites, copper pyrites and pyrrhotite, the copper pyrites sometime forming rather thick seams of solid ore, while in other parts iron pyrites and pyrrhotite occur as solid masses, nearly free from any ore of copper. The country rock is dioritic schist, often rusty on the surface from the decay of sulphides. A shaft had been sunk 65 feet and drifting had been carried on for 20 feet to strike a band of pyritous rock exposed on the surface in a test pit 8 or 10 feet deep. The fahlband character is not prominent, as at the Wilcox mine, and the band of good ore is relatively narrow.

The Big Four property on lots 32 and 33, con. 5 of Foley, not far from the Lafex, was visited, but not enough work had been done to permit a careful study. Four pits, the two deepest of them down perhaps six feet, and some stripping, found all the development. A rusty surface, no doubt representing a fahlband, can be followed several hundred feet, with a width at one point of more than 100 feet. The pits, especially the most easterly one, show that the rock is impregnated with much pyrite, less chalcopyrite, and still less pyrrhotite and molybdenite. The country rock is a gray schist, with flesh colored

schist or gneiss not far off. The fahlband resembles in most respects that of the Wilcox mine, which is four miles to the west, but garnets appear to be wanting. Here, as at the Wilcox mine, the copper pyrites occurs in largest amounts near large crystals of black hornblende.

More or less copper ore is found on numbers of the islands in the Georgian bay near Parry Sound, and for some distance to the south, and very showy specimens of pyrrhotite, said to be nickeliferous, are obtained from the Indian reserve on Parry island, but I was unable to visit the locality. On the small islands DB13, 14 and 16 small deposits of iron and copper pyrites may be seen associated with black garnetiferous hornblende schist, pierced by a rather coarse grained purplish anorthosite.

Dr. Elftman has been good enough to give me an account of copper deposits which I was unable to visit in the township of Carling, at the mouth of the Shebeshkong river. The country rock is gneiss, striking 30° west of north. There are three mineral belts running parallel to the strike, the main central one 40 to 100 feet wide and in one place traced continuously over the bare rock for half a mile, when it runs under a swamp. Apparently it reappears a mile away on the other side of the swamp. There are numerous lenses and stringers of quartz in the fahlband, which has a rougher surface than the adjoining rock owing to its being softer and more easily weathered. The quartz veins run from a few inches to 4 feet in width. A pit 4 feet deep and 10 feet wide across the belt, discloses considerable bornite and chalcopyrite, some masses four inches in diameter. The ore occurs both in the quartz and in the rock between. At six other places along the length of the band copper minerals are found, and Dr. Elftman thinks the property the most promising one in the region after the McGown and Wilcox mines.

PROSPECTS INLAND FROM PARRY SOUND.

A considerable number of prospects may be seen within a few miles of Parry Sound, and brief references will be made to some of them. The Cornfield mine on lots 7 and 8, con. 10 of Foley, not far from the McGown mine, and situated in a similar gray gneissoid rock, shows some copper pyrites and a little bornite; and the adjoining Godard property is like it, but neither appears to be of great importance. At the Macdonald property on lots 24 and 25 of the 7th concession of Foley, a shaft has been sunk about 25 feet, showing no vein or regular ore deposit, but copper pyrites and a little bornite disseminated through rather fine grained gray gneiss. There is also some ore in a pegmatite dike near by which contains no quartz, but large crystals of felspar and hornblende in a finer ground. Copper stains may be seen at various points on the farm. The strike of the schistose cleavage is very variable, directions from 0° to 90° having been observed, and in places there is violent folding with dark bands of hornblende schist interbedded, perhaps originally dikes of diabase.

J. McMillan's property, lot 141, con. B of Foley, a mile or two south of the McGown mine, said to have been disposed of to the Imperial Copper Company for $18,000, is quite interesting geologically. Copper ores, especially bornite, are found distributed through coarse pegmatitic bands of gneiss, in one case a characteristic pegmatite dike having felspar crystals with a bluish shimmer. Stripping has been done and two pits about 6 feet deep sunk, but no vein or definite ore body has been found. Apparently the coarse pegmatite is the bearer of the ore.

On W. J. Nelson's property, lot 19, con. 11 of Foley, the conditions are different, copper pyrites with iron pyrites and garnet occurring partly in coarse gray hornblendic gneiss and partly in a dike of very coarse diorite. At VanKoughnet's, six miles from Parry Sound and a mile south of the Christie road, a little bornite and copper pyrites with some garnet occurs in coarse diorite, the country rock being gray gneiss, the latter also containing a little copper ore with quartz.

Several points were visited in the township of McDougall also, and a few may be mentioned here. On lot 18, con. 1, there are two small openings, one of gray schist or gneiss, the other on a quartz vein, showing chalcocite, bornite and chalcopyrite, mostly diffused through the rock. The quartz vein is of rusty material, suggesting that it might carry gold, but its dimensions are not large, about a foot by 30 feet, so far as could be seen. A similar rock with thin seams of azurite and malachite with a little bornite occurs on lot 17 of the same concession.

It may be added that the copper-bearing belt of rock of the McGown mine extends into McDougall township, but has not been opened up to any important extent, though owned by the same enterprising company.

None of the prospects mentioned have been sufficiently developed to give them any claim to be called a mine, and in most cases there is far too little ore in sight to justify much expenditure upon them. On practically all the properties visited, including some not mentioned above where no work at all had been done, copper ore or copper stains were to be seen, showing that this metal is very widely distributed in the region, but apparently only in small amounts. Nowhere does one see distinct veins or well defined ore bodies, in this respect reminding one of the McGown mine itself, though the latter displays an enormously greater amount of rich bornite and chalcocite ore than any of the neighboring properties. Most of the prospects to be seen inland in Foley and McDougall townships resemble in character the McGown mine rather than the Wilcox, nothing like the extensive fahlbands of the latter with their low grade mixture of iron and copper pyrites having been seen. On the other hand the richer ores, especially bornite and chalcocite, are found only as very small bunches or pockets in the prospecting pits seen by myself.

AGE OF THE PARRY SOUND ROCKS.

The general results of the geological reconnaisance work done near Parry Sound may be summed up here. Scarcely any of the rocks of the region are characteristic members of the typical Lower Laurentian or Ottawa gneiss, though some of the gray gneissoid rocks might not unnaturally be placed there. The absence of associated granites and granite gneisses is suggestive. The ashy looking fine grained gray gneissoid rocks with their "eyes" of felspar and hornblende are probably sedimentary, in origin perhaps volcanic ash, etc., and are more like the Couchiching of Rainy lake as defined by Lawson than the typical Laurentian. The garnetiferous gneiss and mica and hornblende schist, so common in the region, are certainly not Lower Laurentian; some of them resemble the Keewatin rocks of the Lake of the Woods and Rainy lake, and all are more Huronian than Laurentian in appearance. The widespread outcrops of crystalline limestone may be looked on as decisively against putting the region in the Lower Laurentian, and in favor of considering the whole series of rocks as equal to the Grenville series of eastern Ontario; that is, as belonging to the Upper Laurentian or perhaps Huronian series of rocks, which contain most of the deposits of ores and other economic minerals in Ontario. The general character of the rocks of the Parry Sound district, as suggested in the report of the Bureau of Mines six years ago, is not unfavorable to the finding of valuable mines, since they are not Lower Laurentian.

NORTHERN PART OF THE PARRY SOUND DISTRICT.

As reports of important copper-nickel deposits to the north were attracting attention in Parry Sound, and specimens of the ore showed much resemblance to those of Sudbury, it was decided to go north as for as Hardy and McConkey townships, just south of French river, where the most promising deposits had been discovered. The road selected, by Dunchurch to Loring, was characteristic for the region, including sandy tracts, muskegs crossed by corduroy, and steep rocky hills, with a tract of level clay land more or less taken up by settlers. We drove northwest through McDougall, McKellar and Hagerman townships to the village of Dunchurch. In McKellar township a continuation of the limestone band mentioned as occurring at Mill lake may be seen cropping out at numerous points along the road, and specially well shown at a quarry near McKellar village, where limestone is obtained for burning. It contains many fragments of schist and gneiss, as in the outcrops near Parry Sound, but is said to burn to a white and strong lime, useful for building and other purposes. Large masses of white coarsely crystalline limestone occur at Dunchurch also, where the road crosses a stream, and on the hills to the north near the lake shore. At one point here the band is 36 yards wide and is seen to be not less than 40 feet thick where exposed on the shore.

In the township of Mackenzie some copper ores have been found and one deposit was visited, a vein of white quartz with iron and copper pyrites about 8 feet wide, on

which a pit about 8 feet deep had been sunk. The vein is irregular, but can be traced for some distance in each direction. Samples of the ore are said to have yielded $5.80 in copper and gold per ton. The country rock is a gray schist.

Lots 34 and 35 on the 4th concession of Ferrie are looked on as containing copper ore, and a pit has been sunk upon a fahlband containing pyrrhotite, but no copper mineral is to be seen. The same lots of the 5th concession were thought to be ore bearing, iron being the metal this time; and a diorite heavily charged with magnetite has given rise to the idea. Some specimens are probably half magnetite, and rock with magnetite covers about two acres; but it is doubtful if any of the ore is rich enough to be of value.

On the 6th concession, lots 32 and 33, a pit has been sunk about 8 feet on coarse diorite, containing pyrrhotite and copper pyrites, but the impregnation does not seem rich enough nor extensive enough to be of value.

Crystalline limestone of a blue color is found on this farm, and at various points for 20 miles along the road from Dunchurch. The other rocks are mainly dioritic schists, often containing garnets; but there is some flesh-colored gneiss, and pegmatite dikes are common. A supposed apatite (phosphate) mine occurs at the crossing of Deer river, really scapolite in crystalline limestone. The road was hilly and rocky for a few miles out of Parry Sound, then came sandy plains, followed by clay land to Dunchurch, with fair looking farms. On the whole the land seems good for at least 20 miles north of Dunchurch, though much of the surface is rocky and hilly.

A prospect on lot 21, con. 9 of Mills township, shows white quartz of unpromising character, but interesting as containing films of native copper. Crystalline limestone is still to be seen at points along the road almost to the southwest corner of Pringle township, where the route turns to the west through hilly country. Here between the limestone and a dioritic rock a seam of graphite occurs, perhaps 2 inches thick at the widest part, and the same mineral is more or less disseminated through the limestone. As scarcely any excavation or stripping has been carried out, the amount of graphite present is very uncertain. Limestone is seen also in crossing the south end of Mills township, but not after the road turns north again. The band of limestone seems to be very extensive, since it has been seen, with numerous interruptions it is true, at points all along the road from Parry Sound, a distance of about 45 miles in a northerly direction. It is probable that careful examination would show the band to be nearly continuous, though it may be that parts of several bands are exposed along the road.

After the second northern bend of the road the rocks have more the look of Lower Laurentian, coarse whitish and reddish gneiss with some darker bands becoming the prevalent species. No granite was observed, but some schistose rocks resembling anorthosite occur. The road for some distance south and west of the village of Loring passes through good clay land with thick woods, mostly hardwood, but containing also hemlock and some pine. There are numerous clearings and fields, showing excellent crops in a colony of Germans; and afterwards a thrifty looking settlement of English speaking people in Golden valley. The crops were chiefly oats, but fields of peas and wheat were also to be seen. A resident of the region says that in spite of the numerous rocky hills and swamps, about a half of the acreage of the farms is arable, and there is a considerable area of rich woodland still unoccupied.

From the village of Loring various locations in the townships of McConkey and Hardy may be visited by canoe or team. The purchase of two or three properties in these townships by the Parry Sound Copper Mining Company has roused great interest in minerals among the settlers, and almost every farm is supposed to have its ore deposit, the test being the presence of rusty surfaces of gossan, "burns" according to the local idea. In a few cases some development work in the way of stripping or sinking pits has been done, and a number of these prospects have been visited and will be mentioned briefly.

LOCATIONS NEAR LORING.

On lot 7, con. 1 of McConkey, a mass of diabase shows rusty surfaces and contains small quantities of pyrrhotite and copper pyrites, a little garnet and magnetite occurring also.

Several prospects have been found near Cariboo lake, on whose eastern shores the predominent rock is flesh colored granitoid gneiss of Lower Laurentian look, but contain-

ing a few veins of quartz with some pyrites. Towards the west end of the lake coarse diabase or gabbro shows itself. On lot 15, con. 4 of McConkey township, north of the lake there are large areas of rusty diabase, and a pit has been sunk about 12 by 15 feet in area and 6 feet deep. The whole mass of rock thrown out shows more or less pyrite and some chalcopyrite and pyrrhotite, and seams of pure sulphides may be seen, but no definite vein is exposed. It is said that an assay of select ore made by Mr. Heys of Toronto gave 1.55 per cent of copper, 1.20 per cent of nickel, and 1 oz., 3 dwt., 8 gr. of platinum per ton. A sample taken by myself from the bottom of the pit was assayed in the Laboratory of the School of Practical Science and gave 0.37 per cent. of nickel, $1.40 gold, copper none, platinum none.

On lot 18, con. 3, a pit 6 or 8 feet deep has been sunk upon diabase (or diorite) with iron or copper pyrites; and on lot 18 of con. 2 there is an opening on a similar pyritous rock; neither, however, seems of much importance. A specimen from lot 20, con. 3, gave 1.33 per cent. copper and .32 per cent. nickel with a trace of platinum, when assayed by Mr. J. W. Wells.

Several pegmatite dikes appear on the shore of the lake or on islands, and on some of them pits have been opened as mica deposits, from which plates of very fair muscovite several inches square can be obtained. There are also graphitic rocks on the shore of Cariboo lake, but probably not of importance. Most of the pine has been cut near this lake, but there is a considerable amount of hemlock, and very large oak as well as ash and black birch to be seen.

The largest amount of work done upon any property in the region is found at the east end of lake Messagamashine in Hardy township, a little south of one arm of French river and eight miles south of the outlet of lake Nipissing. Here the Parry Sound Copper Mining Company has sunk a shaft about 30 feet deep, unfortunately nearly full of water on Aug. 29. The rock is medium to coarse grained diabase, and the materials on the dump consist of this rock, heavily charged with pyrrhotite, pyrite and chalcopyrite, or of solid masses of these minerals. With the exception of the pyrite, which forms large crystals among the other minerals, this ore greatly resembles some varieties of the Sudbury copper nickel ores. There is a large area of rusty surface near the shaft.

The shores of lake Messagamashine at all other parts except the east end consist of pink gneiss of the Lower Laurentian.

In general the region around the village of Loring is Lower Laurentian in appearance, with numerous basic eruptive masses, chiefly diabase; and the impregnations of ore are found almost only in the latter rock. The majority of the prospects show too little ore to be of importance, and even the two largest openings require much more work before their value is established.

The nearest point on the railway is about 40 miles east of Loring, at Trout creek, with a fair backwoods road most of the way. Crystalline limestone is seen soon after entering Pringle township, showing that the Grenville series replaces the Lower Laurentian, and to the east there are greenish gray schists. On lot 25, con. 7, the Golden Eagle mine is being opened on a band of limestone charged with muscovite, serpentine and a little pyrites. A cross-cut has been made through the limestone, and a shaft was being sunk at the time of my visit, the expectation being that ores of copper and nickel would be found. Nothing on the dump suggested however that these ores occurred in any quantity.

ROCKS NEAR SAND LAKE.

The results of some previous work done in the Parry Sound district in the townships of Proudfoot and Butt, near Sand lake, about 12 miles northeast of Scotia Junction, may be mentioned here. The region to the west, between Sand lake and the town of Kearney, consists largely of sandy plains here and there broken by rocky hills. In general the rocks observed are gray gneisses, coarse or fine grained, and often charged with garnets. The gneiss is often banded with lighter and darker layers, and occasionally flesh colored ones. The mica of the gneiss is generally biotite, but often mixed with muscovite, or altogether replaced by it. Various eruptive masses of a fine grained diorite penetrate it, and a great number of pegmatite dikes. The latter have attracted the attention of prospectors because of the mica crystals they contain. These dikes vary greatly in size

and composition, but even very narrow ones, a foot or less in width, may contain very large individual minerals, both felspar and mica. Most of the dikes contain orthoclase or microcline, plagioclase, very unequally distributed quartz, biotite, magnetite and garnet; all of the minerals in unusually large crystals, except quartz, which seems never to have crystal form. In a few cases muscovite is the only mica, and in others the two micas are mixed. In the largest dike on which work has been done, Dr. Barber's mica mine in Butt township, the various minerals are gigantic in size, microcline crystals reaching a length of three or four feet, mica crystals yielding plates eight or ten inches in size, and garnets beautifully formed but very fragile, perhaps because of the blasting, as much as two inches in diameter. Both varieties of mica occur. In another dike, partly stripped by prospectors, only black mica can be seen, but one crystal had a width of about 24 inches and was several inches in thickness. As this mica is brittle and very opaque, it will probably not be of value, but the muscovite seems of good quality.

Near Elmsdale on the Northern Branch of the Grand Trunk railway an irregular vein of quartz has been opened up as a gold mine, but the ore pile does not look promising. The country rock is diorite or diorite schist, almost black and charged with small garnets. Specimens found near by, and believed in the region to be coal, turn out to be tourmaline.

From the frequency of garnetiferous gneiss it is probable that these rocks belong to the Grenville series, but no crystalline limestones were seen to make the matter certain.

REGION WEST OF LAKE TEMISCAMING.

In company with Mr. Archibald Blue, Director of the Bureau of Mines, a brief visit was made at the latter end of October to deposits of auriferous mispickle and of copper-nickel ore in the region between lakes Temiscaming and Temagami, Mr. Daniel O'Connor serving as guide. The general geology of the region has been excellently mapped and described by Mr. Barlow for the Canadian Geology Survey,[22] and his map was of the greatest service during our visit to the region.

The point is most easily reached from Mattawa, whence a railway line follows the Ottawa to the foot of lake Temiscaming. An excellent passenger steamer plies on the lake, which in its lower part is a very narrow fiord-like body of water, but expands at the upper end to a width of five miles, and has a total length of 61 miles. Its shores in the narrow southern part are mountainous and very impressive. At the upper end the shores are lower and broad plains of lacustrine clay afford good farming land.

We set out for the ore deposits which we were to visit by canoe up the Matabitchouan river, which empties into lake Temiscaming at the mouth of Montreal river. Some old lake terraces near the mouth of Montreal river afford space for two or three farms, and a wagon road leads inland to a wider tract of good land which stands 226 feet by aneroid above lake Temiscaming, or about 800 feet above the sea. At this level there is an excellent farm with good clay soil, owned by Mr. Bronson of Ottawa, evidently deposited when the lake stood that much higher, as the boulder pavement and rocky shore cliff at one side of the terrace show.

The first portage is long and very steep, and there is a rise between lake Temiscaming and the Bass lakes of 270 feet. From this point the river consists largely of a chain of lakes with short rapids between, the largest body of water being Rabbit lake, which is V-shaped, and affords about ten miles of canoe navigation. The rocks observed up to this are chiefly slate with a fairly perfect cleavage crossing the bedding, and slate conglomerate containing red granite boulders. A portage over morainic boulders forming a flat rapid leads to White Bear lake, where Chief Whitebear's band of Indians have their village. This point we made our head-quarters. The chief and some of his men were in our party as canoemen and showed great efficiency.

A half mile portage over morainic material brings one to Net lake, where the ore deposits were found by Mr. O'Connor. The distance in a straight line from Net lake to

[22] Report on the Area included by the Nipissing and Temiscaming Map-Sheets, by A. E. Barlow Report I, vol. x, Can. Geol. Sur., 1899.

the mouth of the Matabitchouan is about 16 miles, but by the crooked course of the river it is about 25 miles, with a fall of more than 380 feet according to Barlow's map. Our aneroid readings correspond well on the whole with the elevations which he has given to the different lakes traversed.

Barlow's report describes the south shore of Net lake as consisting of dark greenish gray felspathic sandstone, followed on the west by intrusive greenstones and flesh red granite, with similar rocks occurring on the east side ; and in the main we found the description correct.

The Big Dan claim, a half mile inland on the southwest shore of the lake, contains a large deposit of auriferous mispickel, the surface of gossan stretching more or less continuously for about a third of a mile in the direction N 30° E, as disclosed by stripping, with a width running in places up to 100 yards. A number of test pits have been sunk upon it, two of them of considerable dimensions. The most southerly pit is 27 feet long, 4 feet wide and three feet deep ; and the ore pile beside it consists of altered slate as country rock, mixed with a large amount of pyrite, chalcopyrite and arsenopyrite (mispickel). The next large opening to the north is a trench on the side of a steep hill, disclosing a band of nearly solid mispickel, 59 feet long and a foot thick on the average, running down at least 10 feet as shown in the trench, but having no distinct walls. Assays show this ore to run $3.70 in gold, $2 52 in silver and 14.4 per cent of arsenic per ton. At the foot of the hill and a little northwest of the trench there is another large pit yielding ore rich in mispickel and containing considerable quantities of copper pyrites, but running low in gold and silver. A hundred yards to the north there is another large pit showing a band of ore rich in mispickel, a sample of which assayed $9.30 in gold and $1.32 in silver. The assays made on these ores run from less than $1.00 to $31.20 in gold and silver, with an average of $5.75 ; and all the samples of ore contain more or less arsenic, so that their treatment by ordinary methods would be difficult. It is probable however that the arsenic from carefully selected ore may be an object of importance, since white arsenic is now quoted at 4½ to 5 cents per pound. It is hard to estimate at present the amount of ore likely to be found in the deposit, but it is probably very great. Although an arsenical ore, it differs greatly from the well known ore of Deloro, since it is largely mixed with other sulphides, is associated with little or no quartz, and does not occur in distinct veins, but rather in shear zones or fahlbands in slate, penetrated by dikes and masses of diabase.

Another deposit of arsenical ore with copper pyrites is said to occur not far to the west, and has been taken in hand by the Canadian Copper Company of Sudbury, two shafts having been sunk, one 30 and the other 15 feet deep ; but we were unable to visit the claim.

The other claims of the region have been taken up for copper and nickel, and generally resemble those of the Sudbury region. The Canadian Copper Company has a camp on the west shore of Net lake with four log houses and other buildings, but they had just closed for the season on Nov. 1, so that we saw little of their work. The Mukwa claim on the west side of the lake belongs to them, and is said to contain a large body of copper-nickel ore like that of Sudbury ; and the Friday No. 1 and 2 claims appear to be similar. On Friday No. 2 there are two openings, displaying heavy masses of pyrrhotite and chalcopyrite, and the rusty rock surface can be traced for a long distance on a hill top.

The Red Hill claim seems to be of a different character, copper pyrites and some pyrrhotite occurring with quartz, in veins sometimes four feet wide, the ore looking like the copper ore of the Bruce mines, though said to contain important amounts of gold.

On the east side of Net lake two claims were visited, the Fairview and the Pike, the former about a mile and a half north of the openings on the Big Dan. On the Fairview there are two small pits and some stripping on a country rock of green slate with gabbro, a little quartzite cropping out near by. The ore is pyrite, pyrrhotite and chalcopyrite with a little arsenopyrite, and except for the pyrite resembles the Sudbury ore in many respects. The amount to be seen is not great however. The Pike claim is a quarter of a mile farther north, and shows a considerable extent of gossan, but the only working is a small pit. The materials on the dump contain pyrrhotite and chalcopyrite like the Sudbury ores, but mixed with a large amount of barren rock.

In general, one may say that ores of nickel and copper undoubtedly occur around Net lake in amounts that will probably prove of importance, but to determine their value

will require a good deal of work. That the Canadian Copper Company have taken hold of some of the claims located here by Mr. O'Connor is good evidence that they consider them of some promise.

In any case it is very significant that 70 miles northeast of Sudbury the same ores occur as at that important mining centre, and apparently in large quantities. It has been shown also that ores very like them are found to the south of lake Nipissing, in a region where Huronian rocks have never been mapped. It is evident that thorough exploration of these vast tracts, covered with forest and moss, and hence difficult to prospect, is likely to disclose great additions to our supplies of nickel and copper ores.

At present access to the Net lake region is difficult, so that the bringing in of supplies is expensive, costing in summer about $1.50 per hundred weight, since everything must go by canoe. In winter, however, the cost may be reduced to 50 cents per hundred weight, by teaming in with sleighs. Easier access could be obtained without any very great outlay, as suggested by Mr. O'Connor, by building a road about eight miles long from lake Temiscaming to Rabbit chute at the northeastern end of Rabbit lake, and putting a steamer on the lake. A dam at Rabbit chute about six feet high would give navigation to the head of White Bear lake. There is a fall of 75 feet on the Matabitchouan river between Rabbit and Bass lakes, and part or all of this might be used for power to run a tram line from lake Temiscaming, making transit easy. There is a large amount of white and red pine to the north and west of White Bear lake, forming an additional reason for opening up the country.

BAIE DES PÈRES.

As we had a spare day before the steamer went down the lake, we crossed over to Ville Marie or Baie des Pères, on the Quebec side of lake Temiscaming, to examine the interesting contact of granite and quartzite conglomerate described by Barlow and Ferrier three years ago[23], as perhaps the only instance where the original floor on which the Huronian rocks were deposited was still preserved. Granite is mapped as forming the two points enclosing Kelly bay, in which Baie des Pères is situated, and also the opposite or Ontario shore of lake Temiscaming. Just south of the village the green, rather coarse-textured quartzite is seen to rest on granite, and to contain angular fragments of all sizes of a greenish granitic rock, evidently greatly altered from the coarse red granite on the point. As described by Barlow and Ferrier, all transitions between the two rocks can be seen, and evidence seems clear that the quartzite, at least in its lower parts, is formed from the rock on which it rests, which must therefore have been solid but greatly weathered granite at the time. An excursion to the north point enclosing the bay showed similar relations, red coarse-grained granite, penetrated by dikes of pegmatite and also of finer-grained granite, becomes greenish gray a little higher up, and is then followed by a granite breccia with large and small blocks cemented by fine-grained chloritic rock. Above this came ordinary quartzite conglomerate in which Mr. Blue found pebbles of red jasper, proving that this basal conglomerate or breccia was formed after the beds of jasper existed, and therefore could not be at the base of the sedimentary rocks of the region. A further discussion of this point will be given later in describing the relationships of Upper and Lower Huronian in Ontario.

A short excursion was made inland to see the old lake terraces and to examine the clays. The farming land of the region stretches miles inland, sometimes between rocky walls of hills, and includes parts of three or four townships. It is white and chalky in appearance and evenly stratified, and was no doubt laid down when the water stood at least 300 feet higher than now. About 2½ miles northeast of Ville Marie church there is a small patch of soft crumbling limestone, largely filled with quartz particles, probably an outlier of the large area of Niagara limestone forming Mann island and part of the mainland north of Temiscaming. It is probable that the lake deposits of whitish clay have originated in the destruction of the limestones in the parts now occupied by the lake, so that the Niagara beds have provided the materials for the extensive and excellent

[23] On the Relations and Structures of certain Granites and Associated Arkoses on Lake Temiscaming, Rep. B. A. A. S., Toronto, 1897, pp. 656-660.

areas of farming land on both the Quebec and Ontario sides of lake Temiscaming, now filling up with settlers and promising to become important agricultural districts. Owing to the great depth of the lower end of lake Temiscaming, navigation remains open very late in the season, even into December, and gives a longer outlet toward the railway than could be expected from this seemingly remote corner of the country.

PLEISTOCENE GEOLOGY.

OLD LAKE BEACHES.

During our past summer's work the chief points in the Pleistocene geology of the regions traversed were carefully noted, and special attention was given to the old lake beaches on the northeastern and northwestern shores of lake Superior. Many raised beaches have been measured previously by various observers, especially Dr. A. C. Lawson[24] and the staff of the Bureau of Mines,[25] but the number of elevations is so great and the difference in height between successive beaches is so small, that thus far it has proved impossible to trace a given beach for great distance around the basin of lake Superior. The fact that many of the old beaches have a succession of wave-built gravel ridges, rising gradually as one walks inland, adds much to the difficulty.

Last summer our work lay mainly on the shore between Port Arthur and the Minnesota boundary at the west end of lake Superior, and between Michipicoton bay and the Canadian Pacific railway on the north.

A number of old beaches were observed on the south side of lake Superior, especially near Houghton in the copper region of Michigan, where Houghton and Hancock are built on a well marked terrace rising 40 or 50 feet above the lake ; while a highest terrace rises about 600 feet, reaching therefore about 1,200 feet above sea level. This beach appears to be higher than any hitherto recorded on the north shore, except two on Mt. Josephine just south of Pigeon point in Minnesota, observed by Lawson,[26] and three rather doubtful ones observed by myself, two on Pucaswa river and one northwest of the "Soo."[27] Mr. F. B. Taylor has described beaches on lake Kaministiquia, west of Port Arthur, as rising still higher, apparently to 670 feet about lake Superior, but these levels seem to belong to a comparatively small lake dammed by the retreating ice before much of the basin of lake Superior was open.[28] This year's work is of interest as showing the existence of a new series of beaches near the watershed between Dog and White rivers, rising much higher yet, the most elevated reaching the level of 843 feet above Superior or 1445 feet above sea level.

Near Cloud creek on the Pigeon river road, leading from the international boundary towards Fort William, a series of terraces may be seen, the lowest rising only 15 feet above the lake. This is well developed on the main shore opposite Victoria island, where well rounded pebbles form a terrace, evidently wave built. In the thoroughly sheltered position of this beach wave action could not build to that height. The beach is more or less bush-covered. The next level is found farther inland, where a plain near Cloud creek slopes gently up from 80 to 100 feet, and a third rises from 236 to 248 feet at the rear of the terrace. Gravel shows upon the latter, but not very well rounded. Lawson records beaches at 8.4, 82 2, 89.7 and 101.4 feet near McKellar's point not far from our observations, which may correspond to our lower beach levels, but does not indicate one at the higher level.[29]

The next series of terraces to be mentioned lies near Wawa lake, and completes the work referred to in last year's report under the head of Michipicoton Post. Mr. Clergue's engineers make Wawa lake 337.6 feet above lake Superior, and a terrace to the north stands 68 feet higher as determined by hand level, or 406 feet above lake Superior, cor-

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[24] Geol. Sur. Minn. 20th, Ann. Rep., p. 182, etc.

[25] Bur. Mines, vol. vii, 2nd Part, 1893, p. 150, etc.

[26] Geol. Sur. Minn., 20th An. Rep. for 1891, p. 252-3. [27] Bur. Mines, 1899, p. 155.

[28] Am. Geol. vol. xx, Aug. 1897, p. 117.

[29] Geol. Sur. Minn., 20th An. Rep., Table of Elevations, p. 280.

responding fairly well with Professor Wilmott's determination of 420 feet. A second water level was determined on the sandy plain between Wawa and the next lake to the east on the canoe route to Missanabie. This stands 111 feet above Wawa, and therefore 449 feet above Superior. It may correspond to a terrace reported by Professor Willmott as lying to the north at a level of 441 feet.[30] Professor Willmott reports two higher water levels in the neighborhood, or perhaps only two stages of the same beach, on extensive sand plains near Magpie river, the lower at 536 feet and the higher at 564 feet above lake Superior, the latter being the more accurately determined. The lower terrace rises about 100 feet above Magpie river, sixteen miles below Magpie lake, and cut banks show stratified clay under sand.

Of greater interest are the well marked terraces found 30 miles to the northwest, near the watershed between Dog river emptying west of Michipicoton bay and White river. On Obatonga lake, an expansion of Dog river, a sandy terrace rising about 25 feet above the water, has an elevation of 780 feet above Superior; while a still higher one is crossed on the mountain portage, between McMaster lake at the head of Dog river and Pokay lake, which empties into White river, well rounded coarse gravel and stones forming a distinct terrace at 843 feet above lake Superior, or 1,445 above the sea. The same terrace has been seen by Professor Willmott at the other end of Pokay lake, about 4 miles to the north, proving that it is of considerable extent. This is by far the highest water level yet recorded northeast of lake Superior, though not so high as some beaches mentioned by Dr. Spencer and the Bureau of Mines from the peninsula between the Georgian bay and lake Huron, 150 or more miles to the southeast.[31] Dr. Spencer's highest beach at Dundalk is 1,690 feet above the sea;[32] and he mentions another water level, the Proton plains, at 1,630; while our highest measurement on the Blue mountains near Collingwood is 1,521 feet. It may be mentioned that the terrace above Pokay lake stands 340 feet above the lowest pass towards Hudson bay, the watershed between Dog lake and the headwaters of Moose river, and so must have been formed in a lake having an ice dam of considerable thickness, or else in an arm of the sea deep enough to submerge all but the higher points in the region. So far no fossils have been found in these beaches to decide between the two theories. So wide a body of salt water, connecting on the one hand with Hudson bay and on the other with the gulf of St. Lawrence, must, one would think, have left distinct evidence of its presence in the way of shells or of other fossils; while an ice-dammed lake might well be almost lifeless, and so leave no fossils.

TERRACES NEAR MEAFORD.

In order to obtain further data concerning the high level beaches on the peninsula between Georgian bay and lake Huron, two days were employed in the neighborhood of Meaford. An excursion northwest of the town to cape Rich disclosed a number of terraces and wave-built gravel ridges, but not at very high levels. At cape Rich itself a well marked terrace with a boulder pavement is found from 46 to 56 feet above lake Huron; and a higher terrace of the same kind, running from 63 to 82 feet, perhaps only a continuation of the former series of beaches. A flat plain, probably representing an old water level, occurs on top of the promontory 351 feet above the lake, and a gently rolling plain, perhaps a water level, at 396 feet. Not far to the southeast of this there is a pretty sheet of water called Mountain lake, dammed by a well defined series of beach ridges of gravel, running from 189 to 220 feet above Georgian bay. This lake, two miles long by half a mile wide, probably represents an old bay cut off by a gravel bar. On road cuttings between the Mountain lake and Meaford fine yellow stratified sand is to be seen.

At Meaford itself there are terraces rising 18 feet and 45 feet above the bay, most of the town being built on the lower level, but part on the upper one. The plain on which the railway station stands runs from 95 to 100 feet above the bay, and seems to be a water level. A somewhat duny ridge of sand stretches across it a little south of the station. Farther south a terrace at 175 feet, showing a good boulder pavement, is followed by the railway for some distance; there is however no very sharp line to be drawn between the 100 foot level and that at 175 feet.

[30] Bur. Mines Rep., 1898, p. 154.

[31] Ibid, p. 152. [32] History of the Great Lakes, p. 78.

Near Field's Crossing the mountain was ascended and an excursion made to the southwest, showing several well defined terraces and a number of more doubtful ones. The rear of the lowest terrace, cut into gray shale, is 27 feet above the bay; while the rear of a second indistinct terrace is at 40; and a more distinct one with a boulder pavement stands at 158, seemingly with stages running up to 198.

Nothing suggesting a water level is seen after this till one reaches the height of 780 feet, where what appears to be a cut cliff occurs, a low escarpment of limestone rising above the slope of red and green shale. This beach must be looked on as doubtful. Somewhat higher there is a considerable extent of plain occupied by fields, and having a low cut cliff of limestone behind it. This level may be recognized across a stream valley which cuts deeply into the tableland called the mountain, and at different points heights ranging as follows were found,—815, 833, 837 and 842 feet. This plain appears to be pretty certainly an old lake level. There are possible terraces also from 869 to 909 feet, and from 968 to 990 feet above Georgian bay, but in the time at command these could not be followed out satisfactorily. The latter may correspond to the well marked terrace recorded by us at the level of 940 feet on the Blue mountains near Collingwood, about ten miles to the southeast,[33] and in that case the beach is deformed. Without working it out in the intervening region however, it is unsafe to make this statement positively.

In general one may say that more or less distinct beaches occur in the Meaford region at about 13 levels, as follows:

1 Terrace	18 to 27 feet.
2	40 to 56 "
3	63 — 82
4	95 — 100
5	158 — 175 (?)
6	189 — 220
7	351
8	396
10	815 — 842
11	869 — 882 (?)
12	896 (?) — 909 (?)
13	968 (?) — 990 (?)

Some of these water levels have been recognized at Collingwood and Owen Sound, but several do not seem to correspond to any before recorded. The highest well defined water level, 842 feet above Georgian bay or 1,422 above the sea, fits very well with several terraces mentioned by Dr. Spencer from the district to the south, e.g. near Mono Mills (1,400), west of Collingwood (1,400), west of Clarksburg (1,396), northwest of Flesherton (1,430), and south of Markdale (1,400 and 1,425).[34]

TERRACES ON LAKE TEMISCAMING.

Another well marked series of old water levels was studied during the summer near lake Temiscaming, 200 miles north of Meaford and 280 southeast of the lofty terraces of the Michipicoton district, showing the very wide distribution of pleistocene deposits laid down in water. When the elevation of these terraces was measured lake Temiscaming was at a very low stage, so that the regular steamers could not land their passengers at the usual docks, but had to send them ashore in small boats or by an "alligator." The level of lake Temiscaming is assumed to be that of low water as determined by Mr. Barlow, 582 feet above mean sea level.

At the mouth of Montreal river a rather faintly marked low level terrace was noted at Bouin's farm, consisting of stratified sand, rising 35 feet above the lake; while a half mile up the lake it rises to 42 feet, or 624 feet above sea level. The next terrace (measured with the hand level) rises 150 feet, or 732 feet above sea, and is formed of gray stratified clay. Two other terraces occur at Bronson's farm, two miles inland; the lower at 773 feet above the sea and the higher at 811 feet, both built of stratified clay. Where it comes against the rocky ancient shore of Archaean schists the highest one has a well marked boulder pavement rising ten or fifteen feet above the plain of clay, which was probably formed at that depth below the actual water level. These clay terraces form excellent soil, as proved by the success of farming operations.

[33] Bur. Mines Report, 1898, p. 151.

[34] History of the Great Lakes, p. 78.

The other terraces observed are on the Quebec shore of lake Temiscaming, near Ville Marie or Baie des Pères. Here also there is sand in the lowest terrace, or perhaps one should say in the deposits formed at high water by the present lake, and clay at the higher levels. Terraces occur at 648, 680 and 707 feet above the sea, and a series of higher ones at 736 and 791 to 796 feet, all of gray or whitish stratified clay, forming good agricultural land. These stratified clays are looked on by Barlow, following Chalmers, as probably laid down by the sea during a time of depression subsequent to the Ice Age;[35] but no marine fossils have been reported from them, though such fossils are common at many points in the Ottawa and St. Lawrence valleys at levels up to about 560 feet.

GLACIAL GEOLOGY.

Not much opportunity was found for the study of glacial geology proper, though more or less boulder clay, and occasionally also moraines, occur in all the districts visited. Care was taken, however, to determine the direction of glacial striae, where they were observed, and a list of them is given. The directions are magnetic, but the variation of the compass is not very great. Near lake Temagami, at the east end of the Province, it was determined roughly to be 6½° toward the west. The degrees are reckoned from north towards east, south, west and north again, a much safer method of recording directions than as east or west of north, since in the latter method a mistake is easily made in writing the points of the compass, while in the method adopted the number of degrees is read directly. In a number of cases more than one direction of striation was noted

Houghton, Michigan, on diabase, 100°.
McKellar point near Cloud bay, diabase on hill top, 45°-55°.
Current river east of Port Arthur, on slate and diabase, main striae, 90°, fainter ones, 115°.
Farther up Current river, on slate, 110°.
Goose point, Thunder bay, 70° and 110°.
Goose point, farther east on shore, 90°.
Port Arthur at railway cutting on diabase, 80° to 90°.
South of Boyer lake, Michipicoton, on hill top, 10°.
East of Boyer lake, mountain top, on soft gray green schist, 35°-40°.
East of Eleanor lake, 30°.
Island in Loon-skin lake, 50°.
Iron locations east of Magpie lake, about 50°.
Dog river, portage past rapids below Heart mountain, well shown on schist, 20°-25°.
Lamp portage at another point, 30°, and an older set, 350°.
Between Dog river and Paint lake, most prominent and probably oldest striae, 0°; other sets at 340° and 20°.
Parry Sound region, Vankoughnet's farm, 35°.
Parry Sound region, Rose Point, 30°.
Parry Sound region, mouth of Seguin river, 30°.
Matabitchouan river, 3rd Portage, 25°.
Matabitchouan river, 4th Portage, 25°.
Falls east end of Rabbit lake, 10°.
Net lake, Big Dan mine, older striae, 345°; younger set (rare), 15°.
Ville Marie, lake Temiscaming, 340°-360°.
Ville Marie, McGregor's hotel, older, 340°, strong striae on quartzite, younger, 110°.
Near Baie des Peres, older striae, 350°-360°; younger, 60°.

The most striking features of the striae recorded above may be briefly referred to. The nearly east and west direction of the few striations noted on Thunder bay is surprising, since the average direction for the general region is about northeast and southwest, the ice being supposed to have advanced from the direction of Labrador; and in addition one would have expected the ice to be deflected into the course of the great depres-

[35] Geol. Sur. Can., 1897, p. 129 I.

sions of the region, which have about the same trend. The striae observed at McKellar Point have about the direction one would expect.

In the Michipicoton district the striae observed are in general about 45°, as might be expected, but those farther north, near Dog river, show great variations, a number trending nearly from north to south. The few striae noted near Parry Sound run as one might expect about 30°-35°; but those seen in the Temiscaming region are much more variable, often presenting two sets of intersecting striae. Those on lake Temiscaming itself naturally trend in the direction of that long fiord-like depression 1,000 feet deep, which must have influenced the flow of the ice greatly. The minor striae, more or less at right angles to the course of the valley, have possibly been caused by icebergs during the depression after the retreat of the main Labradorean ice sheet. Mr. Barlow gives a considerable number of directions of striation from the region, averaging s. 14° w., but the striae from Temiscaming itself come west of north as shown in his table.[36]

NOTES ON THE PETROGRAPHY OF ONTARIO.

During the summer of 1899 the rocks of a number of districts of Ontario were more or less carefully studied, and a considerable series of hand specimens was obtained. The more interesting of these have been studied microscopically, and will be described in the following pages, beginning with specimens from the northwest shore of lake Superior, in what may be called the Thunder bay region.

THUNDER BAY REGION.

The interesting amygdaloid rocks containing copper, in the townships of Crooks and Blake between Pigeon river and Port Arthur, were found to be too badly weathered to be worth study under the microscope, but rock obtained from the end of a drift at the latter copper deposit is quite fresh, and though evidently not in connection with the amygdaloid will be mentioned here. The rock is a rather fine grained, dark gray diabase, containing the usual lath shaped plagioclase with violet augite between, the latter partly weathered to dull green hornblende. The most interesting mineral is biotite, with pale brown and deep brown dichroism, from its appearance apparently an original constituent of the rock. Magnetite occurs in long rough rods, and many needles of apatite are embedded in the plagioclase. This rock is a characteristic example of many of the Animikie laccolitic sills.

An interesting series of rocks occurs near McKellar's point, the long promontory northeast of Pigeon point on the Minnesota side of the International boundary. As the rocks of Pigeon point have been elaborately worked out by Professor Bayley for the U. S. Geological Survey,[37] and those of McKellar's point resemble them greatly in the main, they scarcely need mention here. A dike on top of McKellar's point consists of medium grained diabase, with great crystals of plagioclase thickly scattered through it, probably the rock described by Bayley as porphyritic olivine gabbro; and reddish rocks like his more or less altered quartzites occur also.

An apparent laccolitic sill from Cloud bay, a mile or two north of McKellar's point, presents a rock of quite different type from any described by Bayley, and so will be treated more at length. The rock forms a flat sheet, overlying slates of the Animikie and having the same general arrangement as the laccolite sills of diabase so common in the Animikie; but its paler and somewhat reddish color immediately separates it from them. On the compact reddish gray surface many whitish or pink crystals of felspar may be seen, and also black strips of hornblende associated with them. The rock is much weathered, but in thin sections shows a groundmass consisting of spherulites, apparently of orthoclase or plagioclase, showing dimly a black cross in polarized light, and of micropegmatite between the spherules. Large, well formed crystals of plagioclase, probably oligoclase or andesine from the extinction angles, are enclosed in the ground mass, and also crystals and irregular masses of dark green hornblende, the latter sometimes separate and sometimes beside the felspars, or even embedded in them, show-

[36] Geol. Sur. Can., 1897, pp. 135-6 I. [37] Bulletin No. 109, 1893.

ing that the hornblende was the earliest mineral to crystallize. The rock may be referred to as a granophyric porphyrite.

A number of specimens were obtained from Jarvis island near the silver mine, including slate and graywacke among sedimentary rocks, and diabase and syenite among eruptives. The relationships of these rocks are complex and hard to explain, and a red aplite, or quartz orthoclase granite, adds to the difficulty by appearing sometimes as dikes or stringers in a graywacke, and at others as seeming pebbles in the same rock. The diabases are partly of the ordinary kind, partly olivine diabase. The more acid rocks include one which may correspond to Bayley's metamorphosed quartzite ; and another, which has the general appearance of syenite, green hornblende being mixed with reddish felspar, but turns out to be a granophyric, or micropegmatitic grano-diorite. It contains fairly well shaped crystals of plagioclase, and less often orthoclase surrounded by granophyre, here and there passing into considerable areas of quartz. The hornblende is red-brown when fresh, but is surrounded by green chloritic material, and sometimes almost wholly turned into it.

PARRY SOUND DISTRICT.

A few rocks from the Parry Sound district were briefly described in a previous volume of the Bureau of Mines reports,[38] but the region has received so little attention from geologists that a number of rocks collected during the past summer have been sectioned and studied, and the more interesting of them will be mentioned here. The region includes schistose, massive and sedimentary rocks, the latter however chiefly crystalline limestones. Many of the schists are clearly sheared or squeezed eruptives, but some of them may be pyroclastic, or ash rocks. The eruptives include at one end giant pegmatites, consisting of quartz and felspar crystals, alone or with muscovite and sometimes biotite ; and at the other end gabbros and anorthosites. Diabase dikes, generally so common in the geologically older regions of Ontario, are here quite rare. As the rocks immediately around Parry Sound have been most carefully studied, they will be described first, and in greatest detail.

The rocks enclosing the copper deposits of the McGown mine have the look of rather basic gneisses, are dark gray, rather coarse grained and distinctly schistose; the only minerals recognizable with the lens are biotite and plagioclase. Under the microscope they are in general found to be schistose diorites or gabbros. All contain plagioclase, hornblende and biotite, and all but one or two sections also pale blue green augite and hypersthene As much of the biotite and some of the hornblende have the confused fibrous character belonging to secondary minerals, it is probable that they have replaced augite ; some of the hornblende and biotite seem to be primary however, showing as clear masses in very fresh sections. The hypersthene is trichroic, yellowish, pale green and pale red being the colors shown. Accessory minerals are numerous, including apatite prisms, sulphides and a very little micropegmatite. The felspar is almost altogether a rather basic plagioclase, having extinction angles suggesting labradorite. The rock is hypidiomorphic granular, the schistose structure being apparent only on the large scale, not under the microscope. The series should be called schistose gabbro, or gabbro gneiss.

A specimen of an entirely different kind was found associated with a gold bearing vein at this mine some years ago. It is brownish gray, fine grained, and shows much green epidote in the hand specimen. Under the microscope it proves to consist of quartz, muscovite, garnet and epidote with a little augite, titanite, magnetite and some sulphide. The muscovite is in radiating bundles, showing a black cross with polarized light. The garnet is brown red, resembling melanite somewhat. The rock is evidently greatly weathered, and how it is related to the adjacent schistose gabbro is not certain.

The schistose rock associated with the Wilcox copper mine some miles south of Parry Sound on the whole resembles that of the McGown mine, though with some variations. The most characteristic specimen consists of plagioclase, apparently labradorite or anorthite, blue green pyroxene and hypersthene with some hornblende, magnetite and apatite. The abundant hypersthene has a pleochroism of brownish yellow, brownish green and deep red brown.

[38] Bur. Mines Rep., 1894, pp. 99 and 100.

Two other phases of the country rock were collected, and may be described. One is a massive looking anorthosite, dark gray and of medium grain. The only minerals found in a thin section are anorthite and small quantities of a decomposition product representing augite. Another type is distinctly schistose and contains much red garnet and more or less quartz, as well as iron and copper pyrites, often in sufficient amounts to form an ore. The rock consists chiefly of labradorite, bluish green pyroxene, hypersthene and garnet, with smaller quantities of hornblende and biotite. This rock probably represents sheared and fractured portions of the gabbro gneiss, in whose fissures quartz and sulphides have been deposited, forming the fahlband worked for its copper ores.

Schistose anorthosite similar to that of the Wilcox mine occurs at small copper deposits on islands in Georgian bay, a few miles west; but it is here associated with a black shiny schist, showing very large cleavage surfaces of a mineral resembling hornblende. This proves under the microscope to be hypersthene with red, bluish green and brownish yellow pleochroism. It contains a few definitely oriented plates of a brown mineral like biotite, and also strips of magnetite. The other minerals are hornblende and a little plagioclase.

The schistose gabbros, etc., thus far described, form the main country rocks of the copper deposits of the region, but at Rose point and Parry Sound an interesting series of fine grained white to gray schists of an entirely different character may be found. They are very cleavable, and often bent and contorted in a most complex way. They are often porphyroidal, containing large "augen" of white felspar or black hornblende. The felspars show no twin striæ under the lens, often have curved cleavage surfaces and have rounded forms, embedded in a fine grained, white or flesh colored areole as if resulting from a crushing and rolling action undergone after the crystals were imbedded in their matrix.

The whitish and dark gray varieties of these schists are often finely interleaved with one another, and may fade into one another from point to point.

Studied with the microscope, both varieties have about the same constituents, but in varying proportions, quartz, orthoclase, biotite and hornblende, with a few garnets, and a little magnetite and calcite. Often the granular look of the particles is well marked, sometimes a dusty border separating one grain from another, but at other points the grains seem to interlock in a way suggesting a crystalline massive rock. The whole effect of these gneisses is that of sedimentary rocks, perhaps, as suggested by Dr. Elftman, ash rocks, which have been folded and metamorphosed. The large orthoclase "eyes," sometimes two inches in diameter, seem unusual constituents for a volcanic ash, but the black hornblende crystals are more characteristic of such an origin. Some of the grayer gneisses remind one of part of Lawson's Couchiching gneisses or mica schists in the Rainy Lake region. The ash-like rocks are soft and sometimes even pulverulent, and are wide spread, covering a number of square miles near the town.

At Depot harbor on Parry island, 2 or 3 miles west of Rose point, rocks of a similar kind occur, but apparently passing into more normal Laurentian gneisses. One example of the latter may be described. It is of a grayish flesh color, rather fine grained, and distinctly schistose, having lighter and darker bands. It has a somewhat granular look under the microscope, but consists generally of interlocking anhedra of quartz, orthoclase and microcline, the latter mineral in largest amount. Of darker minerals there are biotite, a little blue green hornblende, titanite and magnetite.

Not far from the ash-like schist at Rose point a hill of very different rock pushes up, apparently by a fault. It is well seen in a rock cutting of the railway, and shows a bluish white ground, with many rounded patches of black and of red. At one point it shows little schistose structure, but when followed up becomes markedly schistose. Under the microscope it is found to consist mainly of plagioclase, running from andesine to labradorite, dark green hornblende, and garnet, with a little orthoclase, or at least felspar showing no striations, muscovite, biotite and magnetite. The dark colored minerals are crowded into irregular masses, hornblende often in the middle with garnets round it, though sometimes magnetite forms the nucleus for aggregations of garnet. The rock may be called a garnetiferous diorite, though it is probable that the colored minerals are largely or wholly secondary, perhaps after augite.

Associated with the schistose rocks just mentioned are bands of crystalline limestone, white, gray or flesh colored, sometimes pure, but often charged with twisted fragments of

the schists. No sections of these rocks were studied from the neighborhood of Parry Sound, but a specimen from a point 4 miles west of Commanda, about 50 miles northeast of Parry Sound, proves interesting. It is greenish gray and coarsely crystalline, weathering yellowish brown. In thin section it reminds one of Eozoön, consisting mainly of calcite and serpentine, the latter in rounded patches, sometimes connected together, but generally separate. The serpentine contains remnants of the original mineral, generally diopside, but in some cases having parallel extinction like olivine. The latter portions may simply be diopside cut at right angles to the plane of symmetry. A number of pale blue rounded fragments of fluorite occur also.

A number of specimens were obtained from the neighborhood of Loring, south of lake Nipissing, and a few have been studied in thin sections.

A dark brownish gray, very coarse grained rock, associated with copper and nickel ores on lake Massagamashine, northeast of Loring, is gabbro, consisting of rather basic plagioclase and much weathered diallage and hypersthene, often with a margin of garnet crystals Magnetite, hornblende and biotite are accessory minerals. This rock is commonly found with ore deposits in the region.

A gneissoid grayish white rock, streaked with black, associated with various sulphides, may be called a diorite or gabbro schist, since it consists chiefly of plagioclase felspar running from andesine to labradorite, with some scapolite and a little augite and hornblende. A somewhat similar rock, but containing many garnets and no scapolite, occurs with a little copper ore on lot 2, concession 4 of Mills township, in the same region.

One of the most interesting rocks found near Loring is a highly graphitic schist, iron black in color, but showing lighter and darker bands. Under the microscope it is found to consist chiefly of quartz and graphite, with a little brown biotite and a very little plagioclase. It was probably at one time an impure carbonaceous sandstone, but now has the character of graphitic quartzite. It was undoubtedly a sedimentary rock in the beginning, and so may take a place with the graphitic limestones, as indicating the Upper Laurentian or Huronian age of the whole series of rocks.

RELATIONS OF UPPER AND LOWER HURONIAN IN ONTARIO.

The original Huronian area, as mapped by Logan and his assistant, Murray, lies within the Province of Ontario, which contains also its northeastern extension toward lake Temiscaming, and several other large and important tracts which have been mapped with more or less certainty as Huronian by Canadian geologists since Logan's time. As these rocks contain the most promising ore deposits of the Province, they naturally attract much attention from prospectors and geologists, and the problems connected with their formation and relationships have an economic as well as a purely scientific interest. The question as to what areas are really Huronian, and as to the relative age of the different areas mapped as Huronian, differing as they often do in striking ways from the rocks of the original region, is one requiring solution if the pre-Cambrian geology of the province is to be placed on an assured basis. During the past summer an examination of the newly discovered iron region in the Huronian district northeast of lake Superior for the Bureau of Mines has provided a set of facts which appear to throw new light on the subject.

Prospectors have followed up the Michipicoton iron range for about 60 miles, and most of this has been traversed and examined by the geologists of the Bureau of Mines, so that its character is now fairly well known. It consists as a general rule of a band of siliceous rock interleaved with thin sheets of iron ore, in many respects much like the famous iron ranges of Michigan and Minnesota. The rock has generally the aspect of a sandstone, but thin sections prove that it is not an ordinary sandstone, in spite of the fact that many parts of it crumble to fine grains under the fingers; for the grains of quartz have polygonal forms that meet in planes, but are only loosely, if at all, cemented. The grains are often six-sided, and in thick sections show a rough dodecahedral shape, the result probably of growth outward from numerous nearly equidistant centers until the grains met, just as spheres crushed together tend to take on a dodecahedral form.[39]

[39] Cf. Irving and Van Hise, Penokee Iron Bearing Series, U. S. Geol. Sur., monograph xix, p. 133, et cetera, where the grains seem to be described as crystals rather than unoriented polyhedra.

The usual variety resembling sandstone sometimes passes into a rock like chert or in other cases jasper, and occasionally takes the appearance of quartzite. In many parts of the range the interbanded sandstone and magnetite or hematite are more or less brecciated, and have undoubtedly undergone great folding and crushing. The band now stands nearly vertical in most regions to which it has been followed.

This band of rock is usually thin, never more than a few hundred yards in width, and there are numerous interruptions in its outcrop, due probably to weathering, for the sandstone variety is so fragile that in river valleys it has been cut down faster than other rocks, and is often lost to sight under the thick drift deposits of the region. This probably accounts for the fact that it was overlooked until last summer, since the region is without roads and hitherto had been explored almost entirely with canoes. The cherty and jaspery varieties, however, stand weathering excellently and form ranges of hills easily followed.

It is almost certain that this band of siliceous rock charged with iron ore is of sedimentary origin, although perhaps not clastic, but rather deposited chemically.

The same association of siliceous rock and iron ore is found more than 70 miles west of Michipicoton, near Pic river, though it is not supposed that the range will be traced continuously to that point, for a tract of Laurentian is mapped as lying between. Whether these rocks should be looked on as a continuation of the Vermilion iron range north of lake Superior in western Ontario and Minnesota and of the Penokee and Marquette ranges to the south of the lake, is not certain at present. Iron miners from Minnesota consider it the same formation as the Vermilion range, and there seems no reason to doubt that it was formed under very similar conditions and shows many points of resemblance to that range.

Sandstones of the same peculiar type occur at Little Turtle lake, east of Rainy lake, and near Fort Frances on Rainy river, as well as at the Scramble gold mine near Rat Portage, on lake of the Woods. Thin sections of these rocks show the same polygonal shapes of the grains of quartz, and more or less iron ore is associated with specimens from each locality. It is very probable, then, that the same horizon exists at points far to the west of lake Superior

Turning toward the south, jaspers and quartzitic rocks interbedded with hematite or magnetite are mentioned by Macfarlane, Bell and others as occurring a few miles north of Batchawana bay;[40] and toward the east, specimens very like the jaspery varieties of the Michipicoton iron range are found interbedded with iron ores near lakes Wahnapitae and Temagami, between Sudbury and the Ottawa river. If, as seems probable, these jaspers are the equivalents of the western Huronian sandstones, we have a definite horizon traceable from point to point across the whole northern end of the Province, a distance of more than 600 miles. It is not suggested, of course, that these iron-bearing sandstones and jaspers will be traced for this distance as a continuous band, for the Huronian areas are separated at several points by tracts of Laurentian; nevertheless, if the conclusions just advanced are correct, we have in these rocks a most valuable thread with which to unravel the much disturbed and complicated series of Huronian rocks in Ontario.

HURONIAN CONGLOMERATES.

Less than 2 miles north of the iron-bearing sandstone of Little Gros Cap, there is a remarkable exposure of schist (or slate) conglomerate, examined many years ago at the mouth of Doré river by Sir William Logan, who evidently considered it a typical example of the Huronian, since he has described it somewhat fully in his general account of that formation.[41] Among other pebbles in the conglomerate he refers to some of a chert-like stone. While studying this outcrop, which is well exposed on the wave-beaten shore at the mouth of the Doré, and also on islands to the south, the present writer found many pebbles, not only of the cherty iron-bearing rocks, but also of the pulverulent sandstones. Pebbles and boulders of all sizes, beautifully rounded and of a considerable variety of rocks—none, however, of typical Laurentian gneiss—are to be seen here in a section dipping from 70 degrees to vertically, and with a measured thickness of more than a third of a mile.[42] The conglomerate has been traced by Professor Willmott and the writer about

[40] Geol. Sur. Can., 1866, p. 130. [41] Geol. Can., 1863, p. 54.

[42] Ont. Bur. Mines, 1898, pp. 165-167.

17 miles from east to west, and probably extended still farther, since small outcrops of conglomerate are found in the east. Belts of conglomerate are seen also within 2 or 3 miles of other parts of the sandstone range, but no search has yet been made for pebbles of sandstone or jasper. It is evident that the Doré conglomerate marks a very important break in the Huronian of the region, and it is probable that the other conglomerates referred to are to be looked on as of the same age. The lack of Laurentian pebbles shows that they are not basal conglomerates of the Huronian resting on a Laurentian floor, and the chert and sandstone pebbles prove that they are more recent than the iron-bearing series.

A very extensive series of schist conglomerates has been mapped by Lawson on Shoal lake east of Rainy lake, and was thought by him to be a basal conglomerate of the Keewatin above the Couchiching.[43] The same region has been examined by Winchell and Grant, who report that black and red jaspers occur in it as pebbles,[44] and by the present writer, who found numerous pebbles of pulverulent sandstone, as well as of cherty materials, along with the more common felsite and porphyry pebbles.[45] This conglomerate has been traced for about 15 miles from southwest to northeast, and probably has a thickness little short of a mile. That it represents a very profound break in the Keewatin series is shown by the fact that among its boulders are some of anorthosite, evidently derived from an adjoining mass of that rock. The anorthosite itself is proved to have erupted through rocks apparently belonging to the Lower Keewatin, since it carried off in its eruption fragments of chloritic and sericitic schist exactly like certain Keewatin rocks of the region. The conglomerate was formed, then, at a far later time than the underlying Keewatin schists, since they must have been solid rocks before the eruption of anorthosite, and this very coarse grained plutonic rock must have had time to cool, doubtless at a great depth, and to be deeply eroded before pebbles of it could have been rolled on a seashore and incorporated in a rock belonging to the upper part of the series.[46] This conglomerate is about three miles south of Little Turtle lake, near which iron-bearing sandstone has been found.

Lawson maps conglomerates of a similar kind on the Minnesota side of Rainy lake, where the river of the same name flows out, and mentions saccharoidal quarts pebbles as occurring in them along with various other kinds of rock.[47] He also describes a conglomerate at the west end of Schist lake, containing pebbles composed of quartz "in a very fine mosaic aggregate, partly chalcedonic."[48] Probably these pebbles are of the same character as the iron-bearing sandstone found by myself a mile east of Fort Frances, on Rainy river. Another important belt of conglomerate containing sandstone and black quartzitic pebbles occurs near Mosher bay, at the east end of the Upper Manitou lake, about 25 miles north of Shoal lake.[49] From the facts just mentioned it will be seen that conglomerates with sandstone pebbles are widely distributed in the Rainy Lake region.

Schist conglomerate also occurs at Rat Portage, a short distance southeast of the sandstone band found at the Scramble gold mine, but up to the present no pebbles of sandstone have been observed in it, though it is probably of the same age as the conglomerates of the Rainy Lake region, 80 or 100 miles to the southeast. We know, also, that jasper conglomerates form a very striking part of the quartzitic rocks of the typical Huronian, and that pebbles of jasper are met with more or less commonly in conglomerates as far east as lake Temiscaming.[50]

The source of these pebbles in the typical region on the shores of lake Huron has not yet been explained, since no bands of jasper have been reported in the neighborhood. Possibly they are concealed beneath the extensive lacustrine deposits of the region, or are sunk below the waters of lake Superior or lake Huron, or the pebbles may have been derived from the ferruginous jaspers near Batchawana bay. From the widespread and abundant occurrence of these jasper pebbles we may infer a source of considerable extent. They can hardly have been obtained from the underlying Laurentian, for jasper has never been reported from the Canadian Laurentain; and since the jasper pebbles are in many cases distinctly stratified and are associated with black chert pebbles, we must suppose

[43] Geol. Sur. Can., 1887-'88, p. 82 F. [44] Geol. Sur. Minn., 23rd Ann. Rep., 1894, p. 66.

[45] Ont. Bur. Mines. 1895, p. 97. [46] Jour. Geol., vol. iv, No. 8, 1896, p. 911.

[47] Geol. Sur. Can., 1887-'88, p. 82 F. [48] Ibid., p. 84 F.

[49] Ont. Bur. Mines, 1897, p. 123. [50] Geol. Can., 1863, pp. 52 and 56.

them to be of sedimentary origin, and so excluded from the Laurentain, employing that term in the usual sense of a complex of ancient eruptive rocks now more or less schistose.

It is true that ferruginous chert is reported by Irving and Van Hise from the Marquette region, associated with the Kitchi schist, which they include in the Basal Complex, but those authors are of opinion that the small deposits referred to are in reality of vein formation, and therefore later in age than the schist which incloses them.[51]

One is tempted to ask if these cherty deposits are not more probably remnants of the Lower Huronian nipped into the Laurentian. The green Kitchi schists themselves would probably be placed by Canadian geologists in the Keewatin or Lower Huronian rather than in the Basal Complex or Laurentain.

THE MOST IMPORTANT BREAK IN THE HURONIAN.

Van Hise, the Winchells and other American geologists who have examined the typical Huronian area are of the opinion that a break occurs in the series between Logan's upper and lower slate conglomerates just above the main band of limestone, and that this is probably the equivalent of the unconformity between the upper and lower iron bearing series of Michigan and Minnesota.[52] My own study of these rocks leads me to the conclusion that this break is not of great significance. There are pebbles of limestone in the upper slate conglomerate showing a certain interruption in the series, but the lower slate conglomerate (or graywacke conglomerate) is very like the upper one and is not appreciably more crystalline or schistose. Specimens from the basal conglomerate east of Thessalon can be perfectly matched by specimens from the upper conglomerate on Echo lake. It is much more probable that the real break is beneath the basal conglomerate near Thessalon. It is likely that some of the green schists found in the adjoining Laurentain are the equivalents of the Lower Keewatin, west of lake Superior, and so represent the Lower Huronian in the typical region.

Much stress has properly been laid on this basal conglomerate by Irving and Van Hise, and it will be well to discuss its bearing on the Huronian question.[53] If the lower part of the typical Huronian series corresponds to the Vermilion and other lower iron-bearing rocks of the States to the west and south of lake Superior, it should contain an equivalent for the characteristic jaspers interbedded with iron ore; but no such rock has been found by Murray in his careful work when mapping the region, nor by any later observers. On the other hand jasper pebbles are found in greater or less numbers to the very bottom of the series, a few occurring in the basal conglomerate itself.[54] If it be admitted that the large numbers of jasper pebbles, often with a banding suggesting sedimentation, are derived from a widespread sedimentary rock, then sediments must have been formed on a large scale and have been consolidated and rolled into pebbles before the basal conglomerate was laid down. It is clear that this basal conglomerate is not the lowest rock in the Algonkian, as defined by Van Hise in his excellent correlation work, nor in the Huronian, as usually defined by Canadian geologists, but that a jasper bearing Lower Algonkian or Huronian is to be looked for somewhere as a source of its pebbles, perhaps the iron range near Batchawana.

On lake Temiscaming, at the northeastern end of the same great Huronian area, another basal conglomerate has been described by Barlow and Ferrier.[55] The reasoning just given will apply to this conglomerate also, for a few months ago Mr. Archibald Blue and the writer found jasper pebbles almost at the base of the Temiscaming conglomerate. In this instance, however, as shown by Barlow in his admirable account of the geology of the region, jasper with iron ore occurring near lake Temagami provides a reasonable source of the jasper pebbles, and proves that the Lower Huronian is represented, to some extent at least, a few miles to the westward.

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[51] U. S. Geol. Sur., monograph xxviii, Marquette Iron Bearing Dist., pp. 186-187.

[52] Van Hise, pre-Cambrian, p. 777; Alex. Winchell, Bull. Geol. Soc. Am., vol. iv, 1893, p. 344, and Am. Jour. Sci., vol. xlii, p. 317.

[53] Cf. Ont. Bur' Mines, 1899, p. 160, et cetera. [54] Ibid., p. 162.

[55] On the Relations and Structure of certain Granites and associated Arkose on Lake Temiscaming. British Assoc., Toronto, 1897; also see Geol. Sur. Can., vol. x, I, pp. 195-9.

CONCLUSIONS.

Granting that the ferriferous sandstones, cherts and jaspers described above belong to a definite horizon near the top of the Lower Huronian (or Algonkian), and that the conglomerates often found near by containing sandstone, chert or jasper pebbles represent also a definite horizon as basal conglomerates of the Upper Huronian, some interesting conclusions follow.

In the first place, the gap between the Upper and Lower Huronian is shown to be a very profound one. Basal conglomerates often thousands of feet thick, and found from point to point over a distance of more than 600 miles, indicate an erosive period of great extent and significance. In the next place, we have in these widespread rocks a means of correlating the often widely separated and very different looking rocks mapped as Huronian in Ontario. Doctor Lawson, in defining his Keewatin on the Lake of the Woods and Rainy lake, came to the conclusion that the highly metamorphosed schists and eruptives of that region stood lower in the geological scale than the less altered quartzites, et cetera, of the typical Huronian as described by Logan. If the ground taken in this paper is correct, viz., that the Shoal Lake conglomerate is at the base of the Upper Huronian and the ferriferous sandstones found at some points in the region belong to the Lower Huronian, it is evident that at least a part of the Keewatin is of Huronian age. Whether the great beds of schist formed of pyroclastic materials and sheared eruptives mapped by Doctor Lawson are older than the Lower Huronian, and so should retain the name Keewatin as a separate formation, need not be discussed here.

The resemblance between the iron-bearing rocks shown to exist in Ontario and the upper and lower iron-bearing series so carefully worked out in Minnesota and Michigan suggests that they are of the same age, and that the break between the Upper and Lower Huronian extends along the south side of lake Superior as well as the north, though it is too soon to state positively that this is the case. The detailed mapping of the Vermilion series of Minnesota to the boundary of Ontario, which Professor Van Hise informs me is about complete, will give an opportunity to trace with more certainty the relations of these two great areas of pre-Cambrian rock.

HERONITE, OR ANALCITE-TINGUAITE.

Owing to the interest connected with the rock from near Heron Bay on lake Superior, described in last year's report as heronite,[56] another visit was made to the locality in order to trace out the relationships of the eruptives of the region. The outcrop of the dike from which the original specimens were obtained was visited again in a cutting on the Canadian Pacific Railway east of mile 804. It was found, however, that the outcrop, which is several feet wide, could not be followed to any distance, nor could its boundaries be clearly seen owing to drift and the debris from the cutting. Another outcrop of similar rock was found between miles 804 and 5, a dike irregular in width, but several feet wide, and with a strike of about 120°. It is darker than the rock from the original locality, and shows few of the concretionary or spherulitic spots so characteristic of it. There also the boundaries are not easily followed, but on one side it touches a dark gray diabase dike and grows finer grained as it approaches the latter rock, evidently being later than the diabase, which is probably of the age of the Keeweenaw eruptions.

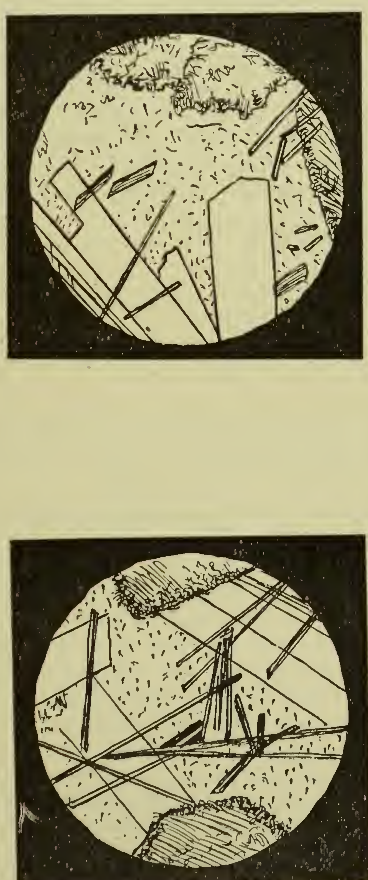
In another cutting, three-fourths of a mile west of the last and west of mile 805, several large and small dikes of rock in general resembling heronite occur, and as these were better exposed than the former outcrops they were studied with some care. Four main dikes show in the cutting from ten inches to six feet in width, running parallel to one another, with a strike of 110°. They can be followed a quarter of a mile to the west, and two or three hundred yards toward the east over rocky, partly wooded hills. The pitted surface, where small spherules have weathered out, gives an easy means of recognizing the dikes, which grow finer grained toward the edge, and seem glassy at the contact with the dark gray Huronian slate they penetrate. Small stringers from the dikes run off into the slate, and fragments of the latter are sometimes enclosed by them, their edges being often somewhat rounded.

[56] Bur. Mines Rep., 1898, pp. 172 and 3.

The texture of these dike rocks is very variable, since they are sometimes filled with small or large concretionary masses; sometimes entirely free from them; sometimes glassy in appearance; at others crystalline looking, with a moderately coarse grain. The largest dike has also the largest concretions, sometimes reaching a width of two inches. The rock as a whole is reddish brown to purplish gray, the spherules being darker in color than the matrix.

Specimens of all types of those rocks were taken and have been studied microscopically. Unfortunately most of them have proved to be very badly weathered. In all that were not too much decomposed, felspars, aegyrite and more or less analcite, with brown iron oxide as a secondary mineral, were to be seen; and in a number there were also evidences of nepheline crystals, now changed to an aggregate of secondary minerals.

When the rock named heronite in last year's report was studied by the writer, he had no access to examples of the rare rock named tinguaite by Rosenbusch, and the description of that rock suggested no special relationship to the specimen from Heron Bay.[57] Since then specimens of tinguaite from various localities have been secured through the kindness of Dr. H. S. Washington and of Professor Pirsson of Yale, and the latter gentleman has given aid in looking up the literature of the subject, so that there has been an opportunity to study the rock and its relationships more thoroughly. Without doubt the rock described as heronite is closely related to the group of tinguaites, which are dike rocks associated with nepheline syenites, though the large amount of analcite and the absence of nepheline seem to separate it from them. An analcite tinguaite described by Dr. Washington[58] comes very close to it however, though it contains 4 per cent more silica and 1.67 less water, the latter indicating a smaller percentage of analcite; which in the rock from Heron Bay reached nearly 50 per cent.



Heronite : Analcite dotted.

Some of the freshest rocks from the new dikes found last summer approach more closely to the tinguaites, since they contain large numbers of crystals of nepheline, now however entirely turned to secondary minerals in the sections studied, and should perhaps be put into that group, the main differences being the large amount of analcite contained by them and the very low percentage of silica. Two of the least weathered specimens were analyzed and will be described with more detail.

The first was from a dike about a mile west of the original locality for heronite between miles 804 and 805 on the railway. The rock is rather dark purplish gray and very fine grained with a few whitish spots, suggesting a porphyritic structure. Thin sections

[57] Mikroskopische Physiographie, band ii, pp. 472-488.

[58] Am. Jour. Sc., vol. vi, 4th Series, 1898, 182, etc.

show many oblong and six sided areas of turbid material, having brownish rims from the presence of limonite, with what looks like a clear glassy ground between, the latter penetrated in all directions by fresh looking green needles of aegyrite. Between crossed nicols it is found that the turbid areas representing nepheline show aggregate polarization, and rarely have any suggestion of parallel extinction. The transparent areas prove to consist mainly of plates of felspar, probably orthoclase, and of analcite. With the selenite plate it is found that very much of the clear material is doubly refractive, though considerable areas show no change of color. The felspar is often fairly fresh looking and not turbid ; and the analcite which fills spaces between the crystals is sometimes fresh and clear also, though more often turbid. Polysynthetic twinning, suggesting plagioclase, was observed but seldom. The only other important mineral is aegyrite, whose green rods and needles penetrate both felspar and analcite impartially, but not the phenocrysts of nepheline, the latter apparently having been the first mineral to crystallize or else having crowded the aegyrite aside, while the analcite came last of all. Since the delicate aegyrite needles run undisturbed from the felspar into the analcite, the latter was almost certainly an original constituent of the rock ; but it is probable that part of the aggregate, formed by the weathering of nepheline, consists of analcite also and theretore is of secondary origin. Much of the aggregate having the form of nepheline crystals is doubly refracting, but part shows no change of color when rotated with the selenite plate. To determine the amount of analcite present a partial analysis was made by myself, the powdered rock being treated with HCl and reduced to dryness to render gelatinous silica insoluble. The amount dissolved was 32 50 per cent., and its composition is as follows :

Al_2O_3	11.90
Fe_2O_3	3.71
Ca O	2.06
Na_2O	7.08
H_2O (at red heat)	4.65
H_2O (at 100°)	.45
CO_2	2.65
Total	32.50

If the CaO, CO_2, Fe_2O_3 and .67 per cent of H_2O necessary to form limonite with the sesquioxide of iron present are removed, we have Al_2O_3 11.90, Na_2O 7.08, and H^2O 3.98, with the ratios of Al_2O_3 .117, Na_2O .114 and H_2O .256, which correspond to the composition of analcite. If an appropriate percentage of SiO_2 is assumed to be combined with these elements, 27.96, the whole percentage of analcite present in the rock is 50.92. If the potash found in the complete analysis (I) is referred to orthoclase, and equivalent amounts of alumina and silica taken as combined with it, the whole percentage of orthoclase is 27.87. The analcite and orthoclase together appear to make up about 78 per cent of the whole rock, leaving only 22 per cent for aegyrite and the secondary minerals.

A second specimen taken from the same locality shows considerable differences from the one just described. The weathered nephelines are much the same, but many of the felspars are lath shaped, resembling plagioclase, and are so arranged as to hint at the diabase structure, the long strips enclosing angular spaces in which the nepheline and aegyrite are crowded. The broader felspars are transfixed by the aegyrite needles, but the lath shaped ones are not. In this specimen both nepheline and plagioclase preceded the aegyrite, and probably the plagioclase came first. No analysis was made of this specimen, so that its chemical composition cannot be compared with that of the first. A third specmen is badly weathered, but in general resembles the second under the microscope.

A number of sections from various phases of the third group of dikes beyond mile 805 were examined, but most of them are too seriously weathered to be satisfactorily studied, especially those showing large concretionary or spherulitic structures. Some of the finest grained, almost glassy looking pieces from the margin of dikes, are greener than the rest of the specimens, and under the microscope are found to consist of an aggregate of products of weathering, containing many small stout prisms of green aegyrite. Other parts contain quite perfect spherulites of orthoclase, showing a black cross in polarized light. No unchanged glass is to be distinguished.

The freshest specimen examined is mottled dark green and red, and on a weathered surface is pitted as if amygdaloidal. The weathered crust is greenish gray to brown, not white as found by Rosenbusch for tinguaites. Thin sections show mainly orthoclase,

pierced by a network of aegyrite needles and some brownish cloudy areas containing much limonite. Distinct outlines of weathered nepheline may be seen, but are much less numerous than in sections previously described from the dike a mile to the east. Not many areas of isotropic material are found, and few lath shaped felspars, but the orthoclases are apt to be plate like and to show a radial arrangement. A complete analysis of this rock has been made by Mr. A. H A. Robinson, fellow in chemistry of the School of Science, and is given in the table of analyses. A partial analysis of the materials dissolved by hydrochloric acid made by myself is given below :

Al_2O_3	12.72
Fe_2O_3	1.22
Ca O	1.01
Na_2O	7.25
H_2O (at red heat)	4.83
H_2O (at 100°)	.47
CO_2	.26
	27.76

The constituents of analcite reckoned from this give a surprisingly large amount, 54.46 per cent, since not much of this mineral can be seen in the thin sections, and it may be that the portion taken for analysis differs from that studied with the microscope. From the complete analysis the total amount of orthoclase may be reckoned at 32.30 per cent.

The following table of analyses includes the one of heronite published last year, the analysis of rock from the dike between miles 804 and 805, and the analysis of the last mentioned rock from a dike west of mile 805, also several analyses of tinguaites for comparison.

—	I	II	III	IV	V	VI	VII	VIII
SiO_2	52.73	48.07	52.03	53.21	52.91	56.75	57.63	54.46
TiO_2	....	....	....	.35	....	.30	.23	trace
Al_2O_3	20.05	18.36	20.58	22.02	19.49	20.69	17.53	19.96
Fe_2O_3	3.43	3.95	3 40	4.18	4.78	3.52	3 46	2.34
Fe O	.99	3 39	1.98		2.05	.59	1.18	3.33
Mn O	....	.55	.13	.42	.41	trace	trace	trace
Mg O	.17	.32	.27	.91	.29	.11	.22	.61
Ca O	3.35	3.76	2.46	1.33	2.47	.37	1.35	2.12
Sr O	....	....	....	....	.09	....	....	....
Ba O	.11	....	....	....	....	....	....	....
Na_2O	7.94	8.72	8.63	10.37	7.13	11.45	5.80	8.68
K_2O	4.77	4.71	5.46	6.41	7.88	2.90	9.16	2.76
H_2O (at red heat)	4.85	4.65	4.83	.81	1.19	3.18	3.22	5.20
H_2O (at 100°)	.69	.45	.47			.04		
P_2O_5	trace	.14	.07	....	trace	....	trace	....
CO_2	.93	2.65	.26	....	....	....	....	....
Cl	....	....	....	....	.53	.28	.08	....
Fl	....	....	....	....	.48	....	....	....
SO_2	....	....	....	....	.52	....	....	....
Total	100.01	99.72	100.57	100.01	100.25	100.28	99.86	99.46
Spec. Grav	2.466	2.60	2.55	....	....	....	....	....

I. Heronite, Heron Bay, Ont., H. W. Charlton analyst, Bur. Mines, 1899, p. 173.
II. Dike between miles 804 and 5, Heron Bay, A. H. A. Robinson, anal.
III. Dike west of mile 805, Heron Bay, A. H A. Robinson anal.
IV. Tinguaite porphyry from Foia, v. Kraatz-Koschlamn. Hackman, Mineralogische Mitthailungan, XVI, 1896, p. 257.
V. Leucite-tinguaite, Magnet Cove, Ark., J. F. Williams, Ig. Rocks, Arkansas, 1890, p. 287.
VI. Analcite-tinguaite, Pickard's Point, H. S. Washington anal., Am. Jour. Sc. (4) 1898, p. 185.
VII. Tinguaite-porphyry, Cone Butte, Judith Mts., Montana ; L. V. Pirsson anal., Weed and Pirsson, Bear-paw Mts., Am. Jour. Sc., (4) vol. ii, 1896, p. 192.
VIII. Tinguaite, Umptek, Kola ; K. Kjellin, anal., Feunia ii, No. 2, 1894, p. 158.

A partial analysis of a dark red specimen from a large dike west of mile 805, made by Mr. G. G. Nasmith in the chemical laboratory of Toronto University, showed that some specimens from this group of dikes are more basic than the one whose composition

is given in II. The silica is 47.45, alumina 20.13 and the sesquioxide of iron (monoxide included) 4.78. Including this partial analysis, it will be seen that the new dikes are somewhat less acid than the one from which the rock named heronite was taken last year, and that all of the analyses show less silica than any tinguaites reported, though the percentage of silica in the leucite-tinguaite from Magnet Cove comes very close to that of heronite. In fact as far as chemical composition is concerned one might start from the biotite-tinguaite described by Eakle from Massachusetts, with 60.05 per cent. $Si\ O_2$,[59] and find all intervening degrees of acidity down to the red dike rock from beyond mile 805 with 47.45 $Si\ O_2$. In other respects the analyses given are on the whole much alike, except for certain variations in the relative amounts of potash and soda and large variations in the amount of water contained. It is very interesting to see that this group of rocks continues the series so well described by Washington in his paper on the Petrographical Province of Essex County, Mass.,[60] starting with paisanite having 76.49 or less silica, passing on to sölvsbergites having 60 to 65 per cent., then to tinguaite running from 53 to 60 per cent., followed by the Heron Bay dike rocks having from 47.45 to 52.73 per cent. of silica. The lowest percentage of silica comes not far from that of the analcite-basalt described by Whitman Cross from Colorado, which has 45.59 per cent; but in other respects the analyses of the two rocks are very different.[61] The rock nearest in composition to the Heron Bay rocks seems to be the tinguaite from Umptek, which has the same percentage of water, a little less potash and about 2 per cent. more silica. I am unfortunately not within reach of the paper in which this rock was originally described. Rosenbusch's description makes it consist of a web of aegyrite, strips of sanidine and albite with sharply idiomorphic nepheline and pseudomorphs of analcite after nepheline and leucite (?).[62]

There are no apparent pseudomorphs of analcite after leucite in the Heron bay rocks, so that they were probably never leucite-tinguaites. On the other hand, all of them which are fresh enough for satisfactory study appear to contain original analcite, for the delicate needles of aegyrite cross from analcite to orthoclase without break or change of character, which would hardly be possible if the analcite is secondary after nepheline. The formation of analcite from the latter mineral implies hydration and considerable expansion, which must have had some effect on the slender prisms of aegyrite. It is probable, however, that in the dike rocks of the region containing aggregates having the form of nepheline, part of the analcite has been formed from nepheline, replacing it; so that secondary analcite exists in this case.

Among the thin sections made from material provided by the kindness of Dr. Washington and Prof. Pirsson, the one which approaches nearest to the rocks described in this paper as coming from a dike between miles 804 and 5, is from Stolpas, Alnoe, Sweden, collected by Hogboem. It is crowded with small crystals of nepheline, generally more or less changed to other minerals, probably zeolites, but not analcite so far as can be determined.

The nearest examples to the rock described as heronite are from Elk peak and Big Grassy peak in the Judith mountains, but neither is closely like the rock from Heron Bay in thin section, since no analcite is to be found, nor is there any marked tendency to a radiate arrangement of the aegyrite needles or the felspars.

From what has been said above, it will be seen how closely the Heron Bay rocks approach the tinguaites, the only important chemical differences being the large amount of combined water present, 4.65 to 4.85 per cent., and the low silica, from 47.45 to 52.73 per cent.; while the main differences observable with the microscope are the tendency to spherulitic structure and the large amount of analcite present. Hitherto, so far as I am aware, analcite has never been recognized as an original constituent of tinguaite, except by Washington in the case of the rock from Pickard's point,[63] but as a secondary mineral it is rather often mentioned. Judging from the analysis of the tinguaite from Umptek with 5.20 per cent. of water, it appears to contain about as much analcite as the Heron Bay rocks (which have from 5.10 to 5.54 per cent. of total water); but in this case the analcite is stated to be secondary after nepheline and leucite.

[59] Am. Jour. Sc., (4) vol. vi, 1898, p. 491. [60] Jour. Geol., vol. vii, No. 2, 1899, pp. 113 to 121.

[61] Jour. Geol., vol. v, No. 7, 1897, p. 689.

[62] Inikrosk. Phys., band ii, p. 484. [63] Jour. Geol., vol. vii, No. 2, 1899, p. 119.

The fact that the rocks from Heron Bay are usually dark red or brown in color depends of course on the amount of secondary iron oxides present, which, though not very large in percentage, are so diffused as to hide the green of the fresh looking aegyrite. If this oxide were removed the rocks would probably have the characteristic green of the tinguaites. If the name heronite had not already been introduced for dike rocks formed essentially of analcite, orthoclase and aegyrite, it might have been as well to call these interesting rocks analcite tinguaites; but the mineralogical differences between them and the ordinary tinguaites seem sufficient to make a new name justifiable.

MINERALS OF ONTARIO, WITH NOTES

By Willet G. Miller

In the following list an attempt has been made to give some of the more important localities in which the minerals of Ontario are known to occur. In the case of the most common minerals only a few of the places in which they occur are mentioned. As many of these minerals are found in innumerable localities, it was thought best to name only a few places in which good specimens have been obtained, if they are only of scientific value, and in the case of common ores the localities given are chiefly those in which the minerals have either been mined or where the deposits appear to be of some economic value. In the case of some of the rarer minerals and ores, all the known localities are given.

In the descriptions of some of the localities it seemed best to quote from the writers who first described the occurrences, or from authorities who have dealt with the occurrence of certain minerals of the Province. In many cases where the occurrences have been pretty fully described by other writers, reference is made to the literature in which the descriptions are given. The minerals and metals are arranged in alphabetical order.

A map prepared by Mr. J. W. Evans accompanies the notes on the localities of nickel. It is now nearly ten years since Dr. Robert Bell's paper and map on the Sudbury deposits was published in the first report of the Bureau, and as many deposits have been discovered since that time it seemed advisable to bring the map more up to date. On the suggestion being made to Mr. Evans, who is well acquainted with the Sudbury district, he agreed to prepare a map.

The list of localities has been taken chiefly from the Reports of the Geological Survey of Canada and from the Reports of the Bureau of mines, and in referring to these reports use is made of the following contractions:

B. M. = Report of the Bureau of Mines, Ontario, 1891 to 1898.
G. C. = Geology of Canada, 1863.
G. S. C. = Report of the Geological Survey of Canada from 1841 to 1899.
R. Com. = Royal Commission on the Mineral Resources of Ontario, 1890.

In referring to lots and concessions or ranges, the Arabic numbers, 1, 2, 3, etc., are used to indicate the former, and Roman numerals, I, II, III, etc, the latter. Thus, 7 IX means that the mineral to which reference is made is found on the seventh lot in the ninth concession or range. The names given for localities are chiefly those of townships.

ACTINOLITE. Frequently occurs in association with Laurentian limestones. The following are some of the localities in which specimens of the mineral have been obtained which are referred to in reports of the Geological Survey and other publications: Clarendon 36 VI; Dalhousie[1]; Elzevir 7 II, 4 VII; Grimsthorpe 8, 9, 10 V; Hungerford II; Kaladar 7 I, 12, 13 I[2]; Westmeath.[3]

SiO_2	56.70	K_2O	0.24
Al_2O_3	1.62	Na_2O	0.64
Fe_2O_3	3.06	H_2O at 100° C	0.64
FeO	7.19	H_2O above 100° C	2.05
MnO	0.30		
NiO	0.54		100 80
CaO	10.62	Sp. gr. at 15° C	2,941
MgO	17.20		

[1] G.S.C. 1898, p. 51 R. [2] B.M. 1893, pp. 89-102. [3] G.S.C. 1892-3, p. 15 R.

ADAMANTINE SPAR. See Corundum.

ÆGIRINE. Heron bay, in an analcite rock, and in other rocks of the Province.
B. M. 1898, pp. 172-3.

AGALMATOLITE. "Under different forms occurs both in the Laurentian and Silurian series, and sometimes forms rock masses among them."
G. C. p. 482.

AGATE. "Agates are found along the entire coast of lake Superior in great abundance, and often of considerable size and beauty. The finest in this region, however, are derived from the trap of Michipicoton island. They also occur on St. Ignace and Simpson's islands, on the former only as nodules in the trap. Both chalcedony and agate occur also as veins, filling dis-

locations and cracks which penetrate the trap in several directions. In the Thunder bay district they are associated with amethysts, occurring also as pebbles. Although these agates are often of rich color and are beautifully veined, they are rarely over two inches across. Many are sold to tourists as ornaments, and many others could probably be disposed of if a little more attention were given to cutting and polishing them. As natural agates their color is exceptionally fine. Nearly all the large agates sold in this region are foreign material, as well as of foreign coloring and cutting."

G. F. Kunz in G. S. C. 1887-8, p. 71 S.

ALBITE. Occurs as a constituent of certain granites and syenites. The mineral is also found in certain apatite deposits and elsewhere. Bromley ; Rathwell's lot, North Burgess ; Ross 5 I. See also peristirite.

ALLANITE. Dalton 25 XII ; Galway ; Hagarty ; Hollow lake, Muskoka river.

Can. Journal, vol. ix, p. 103.

ALMANDINE. This mineral is a constituent of many of the metamorphic rocks of the Province. See garnet.

ALUM. See kalinite.

ALUMINIUM ORE. See corundum.

AMAZONITE. Cameron 6 A, 7 B ; Lyndoch 13 XV[1] ; Sebastopol 31 X.

[1] B. M. 1897, pp 234-7.

AMETHYST. "Amethyst is found in some form in nearly every vein cutting the cherty and argillaceous slates around Thunder bay on the north shore of lake Superior. At Amethyst harbor this mineral constitutes almost the entire vein, and numerous openings have been made to obtain it for tourists who visit the spot. Thousands of dollars worth are annually sold here, and as much more is sent to Niagara Falls, Pike's Peak, Hot Springs, and other tourists' resorts, as well as to the mineral dealers. Surfaces several feet across are often covered with crystals from ½ inch to 5 inches long, rich in color, and having a high polish; sometimes, especially when large, the crystals have a coating of a rusty brown color, owing to the oxidation of the included goethite. This is one of the most famous occurrences of this mineral, regarded as mineral specimens, but the purple color is very unevenly distributed, resembling the Siberian not the Brazilian in this respect, and as the crystals are not transparent like those of Siberia they afford very few gem stones of value."

G. F. Kunz in G. S. C. 1887-8, p. 69 S.

AMIANTHUS. See asbestus.

AMPHIBOLE. See hornblende, actinolite, tremolite and raphilite.

ANALCITE. In amygdaloidal trap of lake Superior. Michipicoton island, with native copper. Heron Bay, lake Superior.

B. M. 1898, pp. 172-3.

ANDALUSITE. Has been reported from a few places, but no well defined specimens of the mineral have been described.

ANDESINE. A constituent of different rocks. North Sherbrooke 16 III, a felspar from "a coarse grained diorite consisting of dark hornblende and a white felspar" has the following composition, which shows it should be placed under andesine but near labradorite.

SiO_2	54.186	K_2O	1.397
Al_2O_3	27.508	H_2O	1.121
Fe_2O_3	0.454		
MgO	0.777		100.868
CaO	9.386	Sp. gr	2.697
Na_2O	6.039		

G. S. C. 1876-7, p. 316.

ANDRADITE. Tudor, Emily mine. Dungannon, titaniferous in nepheline syenite.

SiO_2	36.604	CaO	29.306
TiO_2	1.078	MgO	1.384
Al_2O_3	9.771	Ignition	0.285
Fe_2O_3	15.996		
FeO	3.852		99.577
MnO	1.301	Sp. gr. at 16° C	3.739

Am. Jr. Science, March, 1896.

ANHYDRITE.—Frontenac county, Foxton and Boyd Smith mines in the Laurentain.[1] North Burgess, 4 III. Niagara formation, in cavities and geodes with barite, celestite, etc.

[1] Can. Rec. Science, 1894.

ANIMIKITE. Silver Islet.

Am. Jr. Science, vol. xvii, 1879, p. 486.

ANNABERGITE. Silver Islet.

ANORTHITE. Occurs as a constituent of some igneous rocks.

ANORTHOCLASE. Appears to be a constituent of some of the acidic rocks and those high in the alkalis.

ANTHOLITE. Elzevir 7, 8 XI.

Am. Jr. Science, vol. xlviii, p. 281 and B.M. 1893, p. 98.

ANTHRAXOLITE. A general name proposed by Prof. E. J. Chapman for the pre-carboniferous coal-like materials which occur in different parts of the Province. Under the microscope it shows no trace of vegetable origin, and it occurs in veins and under other conditions which show that it is in all probability an alteration product of petroleum or asphalt. It is sometimes found in the interior of orthoceratites and other fossil shells. A variety from Thunder bay which occurs in regularly banded veins with quartz and iron pyrites had a specific gravity of 1.43 and showed the following composition : Moisture 2.08, additional loss in closed vessel 3.56, ash 0.00, fixed carbon by difference 94.36.[1]

The substance is also found in the Kingston district. In one case crystals of barite and other minerals which occur in a vein in Silurian limestone are coated with the material, showing that it is of more recent origin than the crystals and must originally have been in the fluid state. An analysis of this material gave C. 90.25, H. 4.16, N. 0.52, S. 0.66, ash 0.72, O. 3.69, moisture 0.96 and sp. gr. 1 365.

A substance of similar origin to those referred to occurs in the Sudbury district, Balfour 10 I, etc., and has attracted considerable attention as being a possible source of fuel. It was found by Mr. G. R. Mickle to have the composition of anthracite—C. 94.92, H. 0.52, N. 1.04, S. 0.31, ash 1.52, O. 1.69, moisture 2.48, sp. gr. 1.865.[2]

[1] Can. Journal, vol. x, p. 411. [2] Trans. Can. Inst., April 27th, 1897. B. M. 1896, pp. 159 to 166.

ANTIMONY. See stibnite.

ANTIMONIAL SILVER. Silver Islet.

APATITE. Apatite is found in Canada in greater quantity and in finer crystals than in any other country. The crystals are often of great size and perfection. Magnificent crystals of several feet in length and of fine color are found throughout eastern Ontario in the Grenville series of the Laurentian, at lake Clear and elsewhere. See under sphene.

According to Dr. T. S. Hunt nodules composed in great part of phosphate of lime occur at many localities in the Lower Silurian rocks. The mineral also occurs in microscopic crystals as a minor accessory constituent in various igneous and other rocks.

Since the discovery of the lower grade but more cheaply mined "phosphate" in the south of the United States activity in the mining of apatite for use in fertilizers has ceased in Ontario, although some of the mineral has been produced as a by-product in mica mining and a little of the material has been mined for use in blast furnace work.

It has been stated recently that some apatite is being used in the Province of Quebec in the production of phosphorus by an electrolytic process. Apatite being purer than the southern phosphates is better adapted to this purpose, and it is possible that in time it will come to be used quite extensively for the extraction of the element phosphorous. The following are a few of the important localities in which the mineral has been found in this Province : Bedford 29, 30 I ; Cardiff 22 XIV; Dudley 4 III ; Dysart 11 V; Faraday ; Harcourt 21 XI ; Hinchinbrooke 29, 30 I ; Loughborough 13 X ; Monmouth, 6 X, 14, 15, 17 XI ; Monteagle 26 VI ; North Burgess 4, 5, 6, 7, 8, 9, 10 V, 10, 11, 13 VI, 5, 6, 7, 8 VII, 2, 4, 5, 6, 7 VIII, 5 IX ; North Crosby ; North Elmsley 24, 25, 26, VIII ; Oso 6 I ; Ross 7 I, 13 VI ; Sebastopol 31 XI, 23 XII ; Storrington 2, 4, 5 XIV.

The chief phosphate district of Ontario may be said to be in the form of a belt which crosses the counties of Leeds, Lanark, Frontenac, Addington and Renfrew. Its length is about 100 miles, and its average breadth is over 50 miles.

The literature on the apatites of Ontario is very extensive. Many of the reports of the Geological Survey deal with the subject, as do also the reports of the Bureau of Mines. The phosphate industry is also treated of in the report on the Mineral Resources of Ontario, 1890, pp. 436 to 443 and 167 to 180.

APOPHYLLITE. . . "in foliated masses or plates, often of a red color, associated with calcite in Prince's vein on Spar island, lake Superior."

G. C. p. 482.

ARRAGONITE. This mineral occurs associated occasionally with some of the fossilized organic remains in the Palæozoic strata and under other conditions. "Fibrous arragonite appears to occur sparingly amongst the lake Superior traps ; and occasionally in stalactitic coatings on the sides of cracks in some of our limestone rocks . . "

Chapman, Min. and Geol. p. 125.

ARGENTITE. Is found in a number of deposits in the Port Arthur district, among which are the following : Lybster, Silver Mountain mine ; O'Connor, Beaver mine ; Papinoonge, Rabbit Mountain mine ; Silver Islet.[1]

Wither's Mine, Thunder Bay.[2]

S	13.37
Ag	86.44
Cu	trace
	99.81
Sp. gr	7.31

[1] See G. S. C. 1887, vol. iii, pp. 7 to 131 H for an account of silver and other mining operations on lake Superior. [2] Chapman Min. and Geol. p. 67.

ARSENIC. Edwards island, lake Superior (native). For arsenic-holding minerals see mispickel, erythrite and domeykite.

ARSENIC BLOOM. See arsenolite.

ARSENOLITE. On mispickel, Marmora and elsewhere, e. g., mining location WR3 in township 40 s. E. side of lake Wahnapitæ.

ARSENOPYRITE. See Mispickel.

ASBESTUS. Island s. E. of Rendezvous point, Long bay, Lake of the Woods. Blythfield near Calabogie lake ; Elzevir 7 XI ; Marmora ; Sebastopol 32 XI (serpentinous) ; Ross 8 IX (serpentinous) ; North Burgess (serpentinous)[1] ; O'Connor, Beaver mine.

[1] G. S. C. 1882-3-4 p. 14 L.

ASPHALTUM. Has been observed in small quantities in the limestone of the Corniferous and other formations The so called "gum beds" or mineral tar deposits of Enniskillen may be placed under this heading.

AUGITE. A not uncommon constituent of igneous rocks, such as the Sudbury diabase. See under pyroxene for other localities.

AVENTURINE FELSPAR. "Sunstone or aventurine felspar has been described by Dr. Bigsby in the form of a largely crystallized flesh-red felspar, constituting part of a granitic vein traversing gneiss, 20 miles east of the French river, on the northeast shore of lake Huron, and occurs in fine specimens in Sebastopol."

G. S. C. 1887-8 p. 75 S.

AXINITE. "The rare species axinite is said by Dr. Bigsby to have been found in fine crystals, lining a cavity in a boulder of primitive rock at Hawkesbury."

G. C. p. 493.

AZURITE. Killaly's location, lake Huron ; Batchewana bay and Prince's location, lake Superior, and at other localities in small quantities associated with malachite.

BARITE. "The most abundant source of barytes in Canada will, however, be found in the veinstones of the large bodies carrying copper ores on the north shore of lake Superior, between Pigeon river and Fort William and in Thunder bay."[1] Deposits of the mineral have been worked to some extent in Frontenac county. Bathurst 4 VI ; Dummer ; Galway ; Lansdowne 2 VII ; Levant 22 I ; Madoc 15 VI ; Methuen ; McNab ; McKellar's Island ; North Burgess 4 IX ; Dog lake, Storrington ; Ramsay IV.

[1] G. C. p. 771.

BARYTOCELESTITE. The celestite which occurs in the vicinity of Kingston city contains some barium.

BERYL. Calvin[1] ; Lyndoch 13 XV[2] ; Seine bay, Rainy lake, according to Dr. Bigsby.

[1] G. S. C. p. 14 R, 1896. [2] B. M. pp. 243-7, 1897.

BIOTITE. In addition to being a constituent of many rocks in the form of small flakes and grains, this mineral occurs quite frequently in masses of considerable size. Dungannon ; Herschel ; Monteagle 24, 25 VI ; Ross 13 VI ; Sebastopol 32 XII ; Hyman 6 I, chromiferous biotite.

BISMITE. Lyndoch.

G. S. C. 1895, p. 14 R.

BISMUTH. Native in Tudor, and in rolled pieces of quartz near Echo lake, north of lake Huron. See also bismite and bismuthinite.

BISMUTHINITE. Barrie[1] ; Lyndoch[2] ; Mikado mine, Rainy River district ; Tudor 34 III.[3]

[1] B. M. p. 234, 1897. [2] G. S. C. p. 14 R, 1895. [3] G. S. C. p. 9 L. 1883.

BITUMEN. Occurs in the Utica shales and in limestones of different Palæozoic formations. Bituminous shales, or pyroschists, are described on pages 528, 622, 627 and 728 of the Geology of Canada, 1863. See also petroleum.

BLACK JACK. See sphalerite.

BLUEITE. See under whartonite.

BOG IRON ORE. See limonite.

BOG MANGANESE. See wad.

BORNITE. Bruce Mines ; Mamainse ; Parry Sound ; Point-aux-Mines.

BOURNONITE. Bagot 14 XII ; Darling 22 III.

BYTOWNITE. A constituent of igneous rocks in various localities. Bathurst ; South Sherbrooke.[1] See also Dr. T. Sterry Hunt's analysis[2]

[1] B. M. pp. 226-8, 1898. [2] G. C. p. 79.

CACOXENITE. Elizabethtown 19 II.

G. S. C. 1884-5, p. 304.

CALCITE. Crystals of this mineral have been found at the following localities among others: Bedford ; Bruce Mines ; Galway ; Huntingdon, Kane mine ; Loughborough ; Madoc 9 XIV ; O'Connor, Beaver mine ; Sebastopol, lake Clear ; St. Ignace island, Thunder bay ; Welland, Niagara Falls. "Others perfectly fit for optical purposes were found in abundance

in the upper part of the main shaft of the Galway lead mine in Peterborough county." [1] Stalactites have been found in numerous places.[2]

[1] Chapman Min. and Geol. p. 123. [2] G. C. p. 334.

CALCAREOUS TUFA. Haldimand, Cayuga; Peel, Caledon; Wentworth, Dundas.

CANCRINITE. Dungannon 13 XI.

CASSITERITE. See tin.

CELESTITE. Barriefield common, Kingston, in Silurian limestone; Forks of the Credit in Medina sandstone. Lansdowne 2 VIII.

SO^4	42.51
SrO	56.31
BaO	trace
CaO	0.11
G. S. C. 1894, p. 11 R.	99.93

CERARGYRITE. Silver Islet.

CERIUM. This metal occurs in the minerals columbite and allanite.

CHALCANTHITE. Lake, Hastings county, and other localities.

CHABAZITE. Monteagle 24, 25 VI.

G. S. C. 1892-3, p. 27 R.

CHALCEDONY. Lake Superior in amygdaloidal trap; White Beaver lake on Montreal river, green. See also under agate.

CHALCODITE. Madoc, Wallbridge mine, 12 V.

CHALCOCITE. Bruce Mines; Gould, Barron location; Mamainse; Michipicoton island; Parry Sound.

CHALCOPYRITE. This mineral occurs widely distributed in the Sudbury district and in other parts of the Province. The following may be given as representing a few of the numerous localities in which the mineral has been found: Bastard 24 X; Black river, lake Superior; Black bay, Thunder Bay district; Blezard; Chandos II; Denison; Dummer 30 V; Echo bay, Algoma; Escott 7, 16, 17 II; Garrow; Levant 6, 8 VII; Madoc 25 VII; Mamainse; Mattagami lake near H. B. Co. Post, Nipissing district; McKim; North Burgess 1 VI, 5 VIII, 2 IX; Palmerston 2 IX; Parry Sound; Rock lake, Algoma; Round lake, Thunder Bay district; South Canonto 14, 15 III; Wallace mine; Wellington mine; Wollaston.

CHERT. Occurs among the limestones of the Laurentian, Huronian, Trenton, Niagara and Corniferous.

CHLORITE. A secondary constituent of many igneous rocks, and also occurs in certain gneisses and schists. See clinochlore.

CHLORASTROLITE. "Chlorastrolite, while not occurring on the north shore of lake Superior, is found at Isle Royale and Michipicoton island. This beautiful, stellated gem stone, which is sold to a considerable extent as an ornamental stone on all sides of the lake, is of purely American occurrence."

G. S. C. 1887-8, p. 78 S.

CHONDRODITE. Is found in numerous places in the crystalline limestone of the Laurentian, South Crosby, 27 III, Newboro.

CHROMITE. The metal chromium has been detected in some of the non-titaniferous magnetites of Ontario.

B. M. 1897, p. 233.

CHRYSOCOLLA. Lake Superior, found sparingly among some of the copper ores.

CHRYSOLITE. See olivine.

CHRYSOTILE. See asbestus.

CLINOCHLORE. Bagot 16 VII.

SiO_2	27.23
Al_2O_3	19.44
Fe_2O_3	2.17
FeO	4.91
Cr_2O_3	0.99
MgO	32.67
K_2O	0.08
H_2O	12.04
G. S. C. 1892-3, p. 18 R.	99 53

COAL. "The black, bituminous shales or pyroschists of the Portage-Chemung group contain the remains of terrestrial plants, including a species of calamites, the flattened stems of which are sometimes found to be converted into coal."

G. C. p. 528. See also lignite and anthraxolite.

COBALT. This metal is found in practically all of the nickel ores of the Province, as well as in some of the pyrite of eastern Ontario. It also occurs in traces in some of the mispickel of Hastings county. About 0.5 to 0.6 per cent. of cobalt oxide occurs in some of the iron pyrites of lot 19, concession II of Elizabethtown. The iron pyrites of Escott, 7 II, is also cobaltiferous.

COBALT BLOOM. See erythrite.

COCCOLITE. Beds in crystalline limestone.
G. C. p. 468.

COLUMBITE. Lyndoch 13 XV.
B. M. 1897, pp. 234 to 237.

COPPER. Native copper has been found at the following localities among others: O'Connor, Beaver mine; Point Mamainse; Spar island; St. Ignace island. This mineral occurs at numerous places in the trappean rocks on the north and east shores of lake Superior. Sometimes beautifully crystallized varieties are found associated with calcite, prehnite, laumontite, and at times with red oxide of copper and native silver. Copper ores are sometimes reduced to metallic copper by forest fires. The writer received some specimens of the metal a few years ago from the vicinity of Coe Hill which had evidently been produced in this way. For other copper-bearing minerals of the Province see chalcopyrite, etc.

COPPER GLANCE. See chalcocite.

COPPER SULPHATE. See chalcanthite.

COPPER PYRITES. See under chalcopyrite.

CORACITE. "An ore of this rare metal (uranium) is said to occur at Maimanse, where it forms a vein about two inches in width at the junction of the trap and syenite."

Oxide of uranium	59.30
Lime	14.44
Oxide of lead	5 36
Oxide of iron	2.24
Alumina	0.90
Silica	4.35
Carbonic acid	7.47
Water	4.46
Magnesia	trace
Manganese	"
	98.70
Sp. gr.	4.38
Hardness	3

G. C. p. 504.

CORUNDUM. Burgess 2 IX. "Small crystals of light blue corundum have been found elsewhere in the crystalline limestone of the vicinity."[1] The mineral also occurs as a constituent of igneous rocks—syenite, syenite-pegmatite, nepheline syenite and anorthosite -in a number of counties in eastern Ontario.[2]

[1] G C. p. 500, and G. S. C. 1848, p. 134. [2] B. M. 1896-7-8; G. S. C. 1896-7-8; Am. Geo. Nov. 1899.

COVELLITE. Rainy Lake district.
G. S. C. 1882-3-4, p. 15 K.

CUPRITE. This mineral is occasionally found associated with native copper and other species in the trappean rocks on the shores of lake Superior.

CYANITE. See kyanite.

DANAITE. Graham N½ 6 III.[1] Some of the mispickel of the Hastings district carries a small percentage of cobalt.[2]

[1] Chem. Cont. Geol. Can. 1892 and Am. Jr. of Science 1893, p. 75. [2] Can. Journal 1870, p. 266.

DATOLITE. Loughborough, Smith and Lacey mica mine. "More magnificent crystals of this species have probably never been found in America, and they are equalled by few European specimens. They are pure and transparent, with a yellowish-green tinge, and enclose only a few small crystals of chalcopyrite as impurities. At first glance they resemble large topaz crystals. In size they measure for the largest crystals 3 x 3½ x 2 *c.m.*"[1] The mineral is also stated to occur sparingly in some of the trap rocks of lake Superior.

[1] Am. Jr. Science, pp. 101-102, 1893.

DELESSITE. In the amygdaloids of lake Superior and elsewhere.

DIALLAGE Near Parham station in gabbro or norite, and in rocks of similar composition in other localities.

DIOPSIDE. At High Falls and Ragged Chute on the Madawaska river, associated with green hornblende and black tourmaline. The crystals of pale grayish and green pyroxene, often replaced on their acute lateral edges, are sometimes several inches in diameter.

SiO_2	54.20
CaO	25.65
MgO	17.02
FeO	3 24
Volatile	0.45
	100.56
Sp. gr	3.273 to 3.275

G. C., p. 467.

DISTHENE. See kyanite.

DOG TOOTH SPAR. At different localities in limestone.

DOLOMITE. Crystals of this mineral have been obtained at Bruce Mines and in the cavities and geodes of the Niagara formation; also at the exit of Mazinaw lake, and in North Sherbrooke and elsewhere.

DOMEYKITE. Is found mixed with nickeline in a vein cutting a bed of amygdaloid on Michipicoton island. It also occurs on Silver Islet.

G. C. p. 506.

DYSCRASITE. See antimonial silver.

ELÆOLITE OR ELEOLITE. See nepheline.

EMERY. See corundum.

ENSTATITE. Occurs as a constituent of igneous rocks to the north of lake Huron, Lake of the Woods and elsewhere.

EPIDOTE. This mineral is occasionally associated with the granite and gneiss of the Archæan. It is also found in amygdaloids. At Maimanse crystals of epidote are implanted upon mesolite. Magnetite occurs imbedded in a pale green epidotic rock in Marmora, 12 III. Epidote also occurs with iron ore in other deposits. "A peculiar fine grained reddish gneiss, which is traversed by veins of a pea-green epidote and is very ornamental when polished, occurs near Carleton Place in Ramsay."[1] Tudor 8, 10, 11 XIX.

[1] G. C. p. 833.

EPSOMITE. As an efflorescence on a serpentine rock near the iron ore bed, Crow lake, Marmora. The mineral is also found as an incrustation on the dolomites of the Clinton formation, and in the Utica shales near Collingwood and other places. It is also present in the waters of some springs.

ERUBESCITE. See bornite.

ERYTHRITE. Madoc 2 II, Cross mine; Dominion mine, on magnetite; Prince's mine, lake Superior, as a rose-red incrustation on calcareous spar; S. E. corner Bay of Islands, Bad Vermilion lake; Silver Islet.

FELSPAR. Although this mineral occurs so widely distributed in the Province, the different varieties of it found in most localities have not been definitely determined. Many of the specimens which have been called orthoclase are microcline, and few exact determinations have been made of the lime-soda varieties. See under orthoclase, albite, etc.

FIBROLITE. Dryden 9 III, and elsewhere.

FLINT. Occurs in some of the crystalline and other limestones of the Province, e.g. on Wolfe island in the Trenton, and at Hamilton in the Niagara.

FIBROFERRITE. Rainy River district.

FLUORITE OR FLUOR SPAR. Is found in many localities as a vein mineral. Ross 5 I, 13 VI; Fluor 'island,' Nipigon bay.

FOLGERITE. See under whartonite.

FRANKLINITE. Madoc, Tenney's farm, two miles from Madoc village.

FUCHSITE. Hyman?

GAHNITE. Raglan 2 XVIII, in corundum-bearing rock.

G. S. C. 1896 R.

GALENA. The following are a few of the localities in which this ore of lead has been found: Barrie 5 to 9 IX; Bedford 13 V, 17, VI 18, 19, 21 VIII; Black bay, Granite island; Creighton; Fitzroy 12, 20 VIII; Galway 20 X; Garden river, Victoria mine; Grimsthorpe; Lady Evelyn lake, near north end; Lake; Lansdowne 2, 3, 4 VIII; Limerick 1 III; Loughborough 15, 16 IX; Mamainse, Meredith's location; Marmora; McIntyre, Shuniah mine: McTavish, lot C, 8 VIII; Ramsay 5, 8, IV, 3 VI; Rawdon 4 XIII; Silver Islet; Somerville 1 VII; Tudor XIV; Thunder Bay district, Dorion mine, Cariboo mine, Enterprise mine, Victoria mine, Ogema mine, Silver Lake mine.

GARNET. Different varieties of this mineral are found in the Province. The mineral is frequently met with among the Archæan rocks. Barrie; near Levant station in mica schist; Madoc 11 XI; Green island, Moira lake, Madoc, in mica schist; Marmora; Mamainse, with epidote and other minerals in amygdaloid trap. See also andradite.

GAS (NATURAL). Missanabie river, bubbling water. The great natural gas fields of Ontario are in the districts adjacent to the Detroit and Niagara rivers. These fields have been pretty fully described in reports of the Bureau of Mines and Geological Survey. A very valuable paper on the subject by Mr. Eugene Coste will be published in the proceedings of the Canadian Mining Institute for 1900.

B. M. 1891, pages 115 to 164. G. S. C. 1890-91, pages 1 to 94 Q.

GENTHITE. See nickel-gymnite.

GERSDORFFITE. Denison 12 III; Graham 2 IV.

GIESECKITE. See agalmatolite.

GLAUCONITE. " . . bright green streaks and markings in beds of silicous limestone of the Black River formation in the township of Rama . . . silica, oxyd of iron and water were however detected in its composition, so that it is properly related to glauconite."

G. C. p. 488; also G. S. C. 1858, pp. 195-6.

GOETHITE. In different localities. See under amethyst.

GOLD. This metal has been found at many places in the Province. It may be said that no really large district in the Archæan is without the presence of the precious metal. The two districts in which gold mining is now being actively carried on are widely separated, the one being in the Rainy River country in western Ontario, and the other in the county of Hastings in the eastern part of the Province. Both of these gold-bearing districts have been pretty fully described in the Reports of the Geological Survey and the Bureau of Mines. The following list of places in which the metal has been found will serve to show how widely it is distributed, but they represent only a few of the known localities: Algoma district, in a number of places; Belmont E ½ 19 I, E ½ 20 I; Chandos II; Clarendon 28 VIII; Denbigh,[1]; Galway; Kaladar 25 VI; Levant 10 VI[2]; Marmora 18, 24, 28 V, 4, 5 VIII, 58 IX, 16, 17, 18 XI; Madoc 18 V; Nipissing district; Parry Sound district; Rainy River district, numerous localities; South Sherbrooke 12 II[3]; Thunder Bay district; Vermilion river placers.[4]

[1] G. S C. 1896. [2] G. S. C. 1896. [3] G. S. C. 1896. [4] B. M. pp. 256-9, 1897.

GRAPHITE. Bedford 2 VI, 18 IX; Brougham 12, 18 III[1]; Denbigh 34 IX; Dungannon 28 XIII; Loughborough 6 IX; Marmora 13 VIII[2]; North Burgess 10 I; North Elmsley 7 IX; Parry Sound.

[1] G. S. C. 1896. [2] G. S. C. 1894, p. 12 R. General, B. M. 1896, pages 34 to 38. G. C. pages 792 to 795. G. S. C. 1866, pages 219 to 224.

GYPSUM. Paris and elsewhere along the Grand river[1], and Moose river, 38 miles above Moose factory. The mineral also occur sparingly at times in the Laurentian e.g. Foxton and Boyd Smith mines in eastern Ontario.

[1] G. C. pp. 347-352.

HALITE. See salt.

HARMOTOME. O'Connor, Beaver mine.
Am. Journal Science, 1891, I p. 161.

HASTINGSITE. Dungannon and other townships with nepheline rocks.

SiO_2	34.184	MgO	1 353
TiO_2	1.527	K_2O	2.286
Al_2O_3	11.517	Na_2O	3.290
Fe_2O_3	12.621	H_2O	0.348
FeO	21.979		
MnO	0.629		99.601
CaO	9.867	Sp. gr.	3.433

Am. Jr. Science, Mar. 1896.

HEAVY SPAR. See barite.

HEMATITE This iron ore is found in a number of places in the Archæan rocks, but is of less frequent occurrence than magnetite. It also occurs in the Potsdam formation. One of the districts which is at present attracting much attention in connection with deposits of this ore is that of northwestern Ontario, which lies adjacent to the Minnesota boundary. The ore bearing rocks of this great iron producing State cross the international boundary at this point. Judging both from the character of these rocks on the Canadian side of the line and from the discoveries of iron ore which have already been made over a considerable area in the district. There is reason to believe that the region will become an important iron producing territory. Another district in which very promising deposits of hematite have been found is that of the Michipicoton mining division. A short account of the iron ore deposits of this district is given in the Report of the Bureau of Mines for 1898, pp. 254 to 258.

The following list of localities will give some idea of the distribution of deposits of the mineral in other parts of the Province: Bathurst 2 IV, 20 X, 23 XI; Bedford, 2 VII; Coffin; Clarendon, 29 XIV; Dalhousie, 1 IV; Darling, 16 IV, 22, 23, 24, 26, 27 XI, 26, 27 XII; Elzevir 2 IV; Huntingdon; Madoc 12 V, 10 VI; Marmora, 13 X; McNabb 6 XIII, 6 C. and D.; Palmerston 1 IX; Portland 4 IX, 7 X; South Canonto 7, 8 III; Storrington.

HESSITE. Gold creek, Pine Portage bay, Rainy River district.

Te	35.40
Ag	61 01
	96 41
Sp. gr	7.968

B. M. 1895, p. 105.

HEULANDITE. See under stilbite.

HISINGERITE. Elizabethtown 19 II.
G. S. C. 1874-5, pp. 304 and 315.

HORNBLENDE. Occurs frequently as a constituent of meatamorphic and igneous rocks. Crystals of the mineral have been obtained at the following localities among others: Bathurst 20 IX; Bedford 21 IX; Ross 7 I, 7 IX; Sebastopol 23 XII, 32 XII.

For analysis of hornblende from the anorthosite of South Sherbrooke see B. M., 1898, p. 227.

HORNSTONE. See chert.

HUMBOLTINE. Kettle point, on black shales.

HUNTILITE. Silver Islet. The analysis of this mineral showed a little over one per cent. of mercury among other things.

Am. Jr. Science, vol. xvii, 1879, p. 486

HURONITE. Missanabie station, and in the vicinity of lake Huron and elsewhere. This substance is an altered plagioclase.

See Ottawa Naturalist, No. 2, 1895.

HYPERSTHENE. Is found as a constituent of certain basic igneous rocks, such as the gabbro or norite near Parham station and other places.

ICELAND SPAR. St. Ignace island and elsewhere. See under calcite.

IDOCRASE. See vesuvianite.

ILMENITE. Occurs frequently as an accessory constituent of rocks and in some iron ore deposits. Hastings county, district of Parry Sound, and Lake of the Woods.

ILVAITE. See lievrite or yenite.

IRON. The ores of iron are mentioned under magnetite, hematite and limonite. Native iron has been found in the Province in meteorites, as well as in rock masses. The following two localities are of interest; St. Joseph's island, lake Huron, fifth concession back of Campment d'Ours,[1] Cameron 7 B, in pegmatite vein as spherules in kaolin. See also meteoric iron.

Fe	90.45
Mn	0 75
Ni	trace
S	
P	
Organic matter undetermined	
Insoluble iron metallic	7.26
	98.46
Sp. gr. at 15.5° C	7.257

[1] Trans. Roy. Soc. Can., 1890.

IRON OCHRE. Counties of Halton, Leeds, Middlesex, Norfolk and elsewhere. The material has been worked at the following places: Walsingham 12 XIV, Brant 3 II, Limehouse and Mallorytown

IRON PYRITES. See pyrite.

INDICOLITE OR INDIGOLITE. "The velvet black fibrous tourmaline found at Madoc and Elzevir gives a blue powder, and is evidently an indicolite like the variety from Paris, Maine."

G. S. C. 1887-8, p. 67 S.

JAMESONITE. Barrie 10 VIII, 7 IX.

G. S. C. 1892-3, p. 30 R.

JASPER. "Jasper conglomerate exists in mountain masses, along with the quartzite masses of the Huronian series for miles in the country north of the Bruce mines . . It is a rock consisting of a matrix of white quartzite, in which are pebbles often several inches across, of a rich red, yellow, green or black jasper, and smoky or other colored chalcedony, which form a remarkably striking contrast with the pure white matrix. It is susceptible of a very high polish, and has been made into a great variety of ornamental objects, such as vases, paper weights, etc. Some very beautiful mosaics have been produced by using the rock and included pebbles . . . Considering the abundance of this jasper it seems strange that so beautiful an ornamental stone should have been so long neglected." Jasper of various colours also occurs abundantly inter-banded with iron ores in the districts of Nipissing, Algoma and Thunder Bay.

G. S. C. 1887-8, p. 72 S.

KALINITE. "Occurs in considerable abundance on the exposed face of some high bluffs of argillaceous shale on Slate river, a tributary of the Kaministiquia, about 12 miles west of Fort William."

KAOLINITE. Missanabie river, near the coast. "A red ferruginous variety in strongly soiling particles . . occurs in Madoc and elsewhere in the counties of Hastings and Peterborough."

Chapman, Min and Geol. p. 119.

KYANITE. Kaladar, Golden Fleece mine;[1] Wahnapitæ Station, Algoma.[2]

[1] B. M. 1897, pp 237-8. [2] G. S. C. 1897, p. 160 I.

LABRADORITE. A constituent of some igneous rocks. According to Dr. Bigsby a breadth of five miles along the shore of lake Huron about sixty miles west of Penetanguishene is occupied by felspar rocks, among which are found coarse grained varieties of bluish and gray felspar, with purple, green and flame colored opalesence. Wahnapitæ station. Drummond 1 III. "The mass of the rock is a confusedly crystalline aggregation of the mineral, with quartz, containing embedded large cleavable masses of it, often several inches in diameter. The color is blackish-green, but when polished or moistened with water, and held in the proper light, the before dark and dull surface glows with hues of azure green and gold, rivalling in beauty the plumage of the humming bird. This locality will furnish abundance of this rare and beautiful ornamental stone." As stated under felspar, few of the varieties of plagioclase of the Province have been definitely determined.

LAUMONTITE. In amygdaloidal trap of lake Superior, Mamainse, etc.

LEAD. Kaministiquia, native. See also galena.

LEPIDOMELANE. Drury 2 II; Dungannon 29 XIII, 25 XIV; Marmora 16 VI, 11 IX, 14 X.

SiO_2	32.79	Na_2O	2.00
Al_2O_3	14 34	TiO_2	0.92
Fe_2O_3	4.52	H_2O at 100° C	1.38
FeO	26.32	H_2O above 100° C	3.68
MnO	0.29		
CaO	1.45		99.61
MgO	4.68	Sp. gr. at 15° C	3.19
K_2O	7.24		

G. S. C. 1882-3, p. 15 R.

LEUCOXENE. An alteration product of titaniferous iron ore in many igneous rocks, *e.g.*, in the granite of Barriefield common, Kingston, and elsewhere.

LIEVRITE. Vicinity of Ottawa, in a boulder nearly a foot in diameter.

G. C., p. 465.

LIGNITE. Moose river and other localities.

B. M.. 1894, pp. 124-5.

LIMONITE. This ore was formerly mined in the Province, but of late years it has not been in demand. Charlotteville; Darling; Middleton; North Elmsley; Windham. One of the most important of the recently discovered iron ore deposits in the Michipicoton mining division is described as a brown hematite or limonite.

B. M, 1898, p. 257.

LINTONITE. See under thomsonite.

LITHIUM. See petalite and spodumene.

LODESTONE. "The finely granular ore of Madoc 11 V, sometimes exhibits polarity, constituting a natural lodestone."

LOGANITE. "Associated with the extensive deposit of crystalline phosphate of lime in North Elmsley is a mineral closely resembling the loganite in its characters . . . . A mineral almost identical with this occurs in North Burgess in a pyroxenic rock, with large crystals of a magnesian mica, which last has been wrought to a considerable extent. The results of an analysis of this mineral gave

SiO_2	39.70
Al_2O_3	14 20
FeO	4.50
MgO	25.84
H_2O	16.20
	100 44
Sp. gr.	2.32 to 2.35

LOLLINGITE (Cobaltiferous). Galway 16 XIV.

	I.	II.
As	70.11	70.85
S	0.80	0.81
Fe	24 41	24.67
Co	2 85	2.88
Ni	0.78	0.79
Gangue (quartz)	1.69	.....
	100.64	100.00

MACFARLANITE. Silver Islet.

Can. Nat. Feb. 1, 1870.

MAGNETITE. The magnetites occurring in the Province are conveniently grouped into two classes, viz.: 1. Titaniferous magnetites. 2. Non-titaniferous magnetites. The titaniferous varieties occur in many places in the eastern part of the Province, and in one or two places in the Rainy River district. The following are analyses of specimens from four of these deposits[1]:

—	Fe_3O_4	TiO_2	S	P	Siliceous rock matter.
Minden 11 I	71.22	25.51	0.43	trace	5.13
Glamorgan 35 IV	71.87	13.30	0.06	0.005	15.28
Tudor 55-57 of the Free Grant dist	83.86	8.08	0.08	0.007	9.31
South Crosby 26, 27 VI[2]	69.77	9.8C	0.085	1.520	......

[1] Chapman, Trans. Roy. Soc. Can. 1885. [2] Analysis by T. S. Hunt.

Other well known deposits of titaniferous magnetite are the so-called Boyd-Smith mines near Parham station and the Chaffey mine near Newboro on the Rideau canal. The percentage of titanium in these ores varies greatly. In some cases it is present in little more than traces while in other cases it is present in percentages so high that the iron is largely replaced.

Attempts have been made to work some of these deposits, but at present nothing is being done with them on account of difficulties which it is claimed are met with in smelting them. All of these titaniferous ores contain nickel and are believed to be of igneous origin. They are associated with gabbro-like rocks [1].

The non-titaniferous magnetites are of aqueous or sedimentary origin.

The following are some of the localities in which magnetites of one or the other of the two classes mentioned occur : Airey ; Bagot 14 VII, 16, 21 VIII, 16 IX, 23 X, 16, 18, 22 XI [2] ; Bathurst 11, 12 VIII, IX; Bedford 2, 5 II, 2, 3, 5, 6 III, 1, 4, 7, 8, 9 IV, 1, 3, 7 to 11 V, 2 VI, 2, 3, 4, 7 VII, 21 IX; Belmont 8, 19 I ; Carlow 6, 7 XVI ; Darling 22 III, 22 IV, 25 V ; Digby 15 VIII ; Dungannon 25 XIV ; Galway 23 XII, 27 XIII ; Glamorgan 35 IV, 30, 31 XIII ; Levant 13 III, 4 VII, 4 XII ; Lutterworth 5 V, VI, 16 VII ; Madoc 2, 12 IV, 11 V, 10 VI, 9 VII ; Marmora 7 I, 13 II, 12 III, 6, 9 IX ; Minden 11 I ; North Crosby, 1 VI ; Palmerston 3, 4 IX, 8 X, 27, 28 XI ; Portland 5 XIII ; Seymour 25 XII ; Snowdon 20 I, 33 III, 25, 26, 27 IV ; South Crosby 26, 27 VI ; South Sherbrooke 3, 14 I, 17, 18, 19 III ; Wollaston 15, 16 II, 16, 17, 18, 19 VIII, 9, 10 XV.

The non-titaniferous magnetites of western Ontario differ for the most part considerably from those of the eastern part of the Province. Those of the former region, especially those of the Rainy River and Thunder Bay districts, are frequently very fine grained and slaty in appearance, and are associated with rocks which often hold a high percentage of jasper and related minerals. The non-titaniferous magnetites of eastern Ontario are usually much coarser in grain and are associated with rocks of a different character. In many cases the rock on one wall of these deposits is crystalline limestone, while that on the other varies in different deposits. Frequently however it is some variety of scapolite bearing gneiss.

The development of our iron ore deposits is as yet only in its infancy. In working the deposits of the eastern part of the Province we should draw upon the experience which has been gained in working the deposits of the eastern United States, which are similar in character. The iron ores, both hematites and magnetites, of the Michipicoton, Thunder Bay and Rainy River districts are on the other hand, like those of the States of Michigan and Minnesota, and the knowledge gained by workers of the deposits in those States should prove of great value to us in developing the iron resources of our western districts. The following are some analyses of non-titaniferous magnetites from eastern Ontario, given in a paper, by Prof. E. J. Chapman, published in the Trans. Roy. Soc. of Canada in 1885.

	FeO	Fe_2O_3	MnO	S	P	Siliceous rock matter.	$CaCO_3$	Amount of metallic iron deduced from oxides.
1. Snowdon 26 IV	26 20	58 72	..	0.16	0.01	15 02	....	61.48
2. " 20 I	24.87	58.35	0.13	0.04	0 08	15.58	....	60.18
3. " 25 IV	76.72		0.11	0 08	0.02	23.84	....	55.00
4. " 27 IV	69.62		. .	trace	trace	29.94	0.48	50.41
5. Galway 27 XIV	86 83		trace	trace	trace	13.27	....	62.87
6. " 23 XII	86.46		1.27	trace	0.01	12.18	....	62.60
7. Lutterworth 5 VI.	76.12		......	trace	trace	23.80	....	....
8. Glamorgan 27 XIII	30.06	67.14	.. ..	trace	trace	2.74	.... ..	70.38
9. Monmouth 30 XIII	30.08	67.27	......	trace	trace	2.58	....	70.50
10 Belmont 19 I	27.22	61 56	......	0.04	trace	11.13	....	64 26
11. Burleigh	27.14	60.82	......	0.03	trace	11.54	0 61	63.68
12. Madoc 25 VI	28.40	67.23	trace	0 03	0.04	3.32	0.87	69.16
13. " 11 V	25.79	57.52	trace	0.52	trace	15.54	.... ..	60.32
14. " 11 V	26.68	59.71	.....	0.38	0.03	13.16	0.11	62 54
15. " 18 I	29.47	65.68	.....	0.07	0.01	4.74	....	68.90
16. Wollaston 15, 16 VIII	26.12	65.20	......	0.09	0.02	8.48	....	....
17. Tudor 6, 7 8 XIX	28.32	63 24	......	0.02	trace	8.36	....	63.30
18. " 18 XVIII.	29 18	64.95	......	0.13	0.01	5.66	....	68.16

[1] B. M. 1897, pages 230-2 and Proc. Brit. Ass. Ad. Science, 1897. [2] G. S. C. 1895, p. 19 R.

MALACHITE. Lake Huron, lake Superior, Madoc, Marmora, Parry Sound and elsewhere with other copper ores.

MANGANESE. This metal occurs in small amounts in some of the iron ores of the Province. See also manganite, wad and rhodochrosite.

MANGANESE OCHRE. See wad.

MANGANITE. "At Batchewaning bay on lake Superior, near the southeast end of the Upper Canada Mining Company's location, and not far from the shore, is a large vein of manganese ore. . . . A specimen was found by assay to be equal to 60 per cent of peroxide of manganese."

G. C. p. 754.

MARCASITE. Hinchinbrook, Silver Islet, Neebing 25 V.
Can. Journal, 2nd series x, p. 408.

MARSH GAS. Is abundant in some mineral springs where it keeps the waters in constant agitation.

MARTITE. Dalhousie 1 IV ; in a gneissoid boulder from Bass lake a few miles north of Orillia.

MELANITE.—Marmora and elsewhere. See garnet.

MELANTERITE. Occurs on decomposing pyrite and marcasite in many localities, e.g., Hastings and lake Superior. "A specimen of iron pyrites from the Galway lead mine in . . . Peterboro', became covered in the course of a few weeks with delicate tufts of minute acicular crystals of the mineral."
Chapman Min. and Geol. p. 133.

MENEGHINITE. Barrie 5 to 9 IX.
Trans. Roy. Soc. Can. 1883.

MERCURY. See under huntilite.

MESOLITE. "At Mamainse crystals of epidote are met with implanted upon mesolite, and rarely associated with small brown garnets"

METEORIC IRON. Madoc. "The specimen was found in 1854 upon the surface of a field and weighed 370 pounds. Its shape is rudely rectangular, and flattened on one side. The surface is irregularly pitted, as is generally the case with meteoric masses, and coated with a film of oxide of iron. The iron is malleable and highly crystalline in texture, and when etched by an acid exhibits beautifully the peculiar markings which are known as Widmanstattian figures. Its analysis shows it to be an alloy of iron with 6.35 per cent of nickel. Small portions of the phosphoret of nickel and iron are disseminated through the iron, and, in making a section of it, rounded masses of magnetic iron pyrites were met with."[1] This meteorite is now in the collection of the Geological Survey, Ottawa.

Thurlow meteorite. Found May 12th, 1888, on lot 28 VI, Thurlow, Hastings county. Weight of original mass 11 lb. 15¼ oz.

In Ward's "Descriptive Catalogue of Meteorites," Rochester, 1892, two other meteorites found in Ontario are described.

One known as the Welland meteorite is said to have been found April 30th, 1880, about one and one-half miles north of the town of Welland. It is stated to be a kidney shaped mass, and its total weight after being freed from all loose scales was 17¾ lb.[2]

Fe	91.17
Ni	8.54
Co	0.06
S	0.07
	99.84
Sp. gr	7.87

The De Cewsville Metorite. "It fell in the village of De Cewsville about 2 P.M., Jan. 21st, 1887, striking in the ditch on the south side of the street known as the Talbot road, opposite lot No. 43, con. 1. The ditch at the time contained about a foot of water, from a recent thaw, which was covered with thin ice. The meteorite made a hole in the ice about a foot in diameter. The whizzing noise in the air and the splash in the water were heard and the latter seen" by one person who was about 15 feet distant from the spot struck, and by two others who were near at hand. The meteorite seemed to have come from the west. It was found, after the melting of the snow and ice, on Feb. 16th. Its weight is about 12 oz. and its specific gravity 3.52, which is somewhat greater than that of most æorlites, and it doubtless contains a little more iron than is usual in meteorites of this class.[3]

[1] G. C. p. 508. [2] Proc. Rochester Acad. Sci. vol. i, 1890. [3] Ibid.

MICA. The mining of amber mica is a somewhat important industry in the county of Frontenac and adjoining territory in the eastern part of the Province. The village of Sydenham has been one of the chief centres of the industry. The mineral has been mined to some slight extent in other parts of the Province. Good specimens of mica have been obtained at different places in the region north of lake Huron.

The following are some of the localities in which specimens of merchantable mica have been obtained : Cardiff ; Effingham ; Hungerford ; Levant ; Loughborough 8 III, 11 VII, 5, 8 VIII, 16, 17 IX, 7, 8 X ;[1] Methuen 14 IX. 14 X ; Miller 4, 5 XI ; North Burgess 2 IV, 16, 17 IX ; Palmerston 24 II ; South Canonto ; Wilberforce Station. Chrome-magnesia mica occurs on 6 I Hyman.

See also biotite, muscovite, phlogopite, sericite and fuchsite.

[1] B. M. 1892, pages 249 to 250.

MICROCLINE. Much of the so called orthoclase proves on close examination to be microcline. See also amazon stone and aventurine.

MILLERITE. Has been reported to occur in the Sudbury district in the massive form

MINERAL WATERS. These are somewhat widely distributed in the Province and differ greatly in the amount and character of the salts dissolved in them. Accounts of these waters

are given in the Geology of Canada, 1863, and in other reports of the Geological survey, especially in those parts of the annual reports entitled "Mineral Statistics" and "Chemical Contributions." In the Report of the Bureau of Mines for 1891, pages 60 to 62, an account is given of the mineralized artesian waters of the Province.

The following table shows the composition of a few of the mineral waters of Ontario. The analyses are taken chiefly from the Geology of Canada, 1863, where it is stated that "The mineral waters of Canada can be arranged in six classes, according to their chemical composition. In the first three classes chlorids predominate ; in the fourth, carbonates ; and in the fifth and sixth, sulphuric acid and sulphates. The waters of the first, second and third classes are neutral ; those of the third and fourth are alkaline ; and those of the fifth are acid."

—	1	2	3	4	5	6	7	8	9
Chloride of sodium				17.8280	18.9158	29.864	12.2500	6.9675	6.5325
" potassium				0.0920	traces		0.0305	0.0309	0.1160
" barium									
" strontium									
" calcium				12.8027	17.5315	12.894	0.2870		
" magnesium	.0878			5.0737	9.5437	6.954	1.0338		
Bromide of sodium				0.1178	0.2482			0.0150	0 0217
" magnesium							0.0238		
Iodide of sodium					0.0008			0.0005	0.0032
" magnesium							0.0021		
Sulphate of alumina			.4681						
" lime	1.1267	1.240	.7752	0.7769	.0396				
" magnesia	.4351	.207	.1539		.492				
" potash	.0510		.0608					0.0053	
" soda	.4718		.0502						
" protoxyd of iron			.3638						
Phosphate of soda									0.0124
Carbonate "								0.0485	0 5885
" baryta									traces
" strontia					traces				traces
" lime	.3050	.198		traces	0.0411	0.370	0.1264	0.1480	0.1500
" magnesia	.0179				0.0227	1.287	0.8632	0.5262	0.7860
" iron	traces				traces		traces	traces	traces
Phosphoric acid			traces						
Hydrated sulphuric acid			4.2895						
Sulphuretted hydrogen	.1776								
Alumina							traces	0.0044	0.0040
Silica							0.0225	0 0310	0.1330
In 1,000 parts of water	2.495	1.645	6.1615	36 6911	46.3038	52.257	14.6393	7.7773	8.3473
Specific gravity			1.0058	1029 1		1043.2	1010.9	1005.8	1006.24

1. Charlotteville 3 XII, Corniferous formation. "A remarkable sulphurous spring, belonging to the sixth class. . . . The water fills a natural basin, covering about 100 square yards, from which the discharge was found to be about sixteen gallons a minute. The water rises through several holes in the mud at the bottom of the basin. This is covered with a layer of sulphur and carbonate of lime, a mixture of which incrusts leaves and twigs placed in the spring. The water is remarkable for the predominance of earthy sulphates and for the great amount of sulphuretted hydrogen which it contains, amounting to 11.6 cubic inches in 100 cubic inches of water. . . The temperature of this water in the basin was 45°F. . . It is limpid and sparkling, and pungent to the taste from the great amount of sulphuretted hydrogen it contains."[1]

2. Brant, lot 53.

3. Tuscarora, known as the sour spring, is upon the Indian reserve about nine miles south of Brantford and three miles south of the bank of the Grand river. The water is kept in constant agitation by a discharge of inflammable gas. The presence of sulphuretted hydrogen is also evident from the odor.

4. The water is from a salt well about two miles east of the village of Ancaster.

5. Whitby. A copious saline spring occurs at Bowerman's Mills, 32 III. Contains an abundance of bromine, but only traces of iodine.

6. "In boring for water at Morton's distillery in Kingston two mineral springs were met with. . . . They are remarkable for the large proportions of sulphates and earthy carbonates which they contain." The analysis given is from what was known as the upper well.

7. Caledonia. The spring from which this water is taken is known as the intermittent spring on account of the intermitting discharge of carburetted hydrogen gas.

[1] G. C. pages 536-7.

8. Caledonia. This water comes from what is known as the gas spring, something like 300 cubic inches of carburetted hydrogen gas being evolved per minute. Trenton group.

9. Fitzroy, 10 II, Gillan's spring.

MISPICKEL. This mineral is found associated with gold in a number of widely separated places in the Province. At Deloro in Marmora oxide of arsenic is produced along with gold. This appears to be the only district in America producing arsenic, although one locality in the western United States is referred to in certain text-books. Barrie ; Marmora ; Lake ; Tudor ; Lake Temagami district ; Rainy River district. The mineral is found sparingly in the last districts, and associated with copper ores at the Bruce Mines and Thunder bay. See also danaite. A cobaltiferous mispickel from the township of Graham was found by Mr. G. R. Mickle to have the following chemical composition :

As	47.60	S	4 59
Fe	46.27	Co	1.52

MOLYBDENITE. There are numerous localities in which this mineral occurs, among which are the following : Dungannon ; Harcourt 3 I ; Miller 3 VIII ; Monteagle 26, 27 VI ; North Crosby ; Ross 22 II, 7 IX ; Terrace Cove, lake Superior, in small quantities in a quartz vein.

MOLYBDITE. Ross 22 II.

MORENOSITE. Denison 12 III ; Drury 2 II ; Wallace mine at the mouth of the Whitefish river.

MOUNTAIN LEATHER. O'Connor, Beaver mine.

MUSCOVITE. Occurs widely as a constituent of crystalline rocks. Good specimens of the mineral have been obtained at the following places among others : Calvin 16 II ; Dungannon 20 X ; Methuen, on different lots in concessions IX and X ; Miller 4 XI ; Matawatchan (chromiferous); Lake of the Woods.

NAGYAGITE. Moss, Huronian mine ?

NATROLITE. "Occurs, but mostly in a weathered condition and in part altered to carbonate of lime, in some of the amygdaloidal traps of lake Superior."
Chapman Min. and Geol. p. 113.

NEPHELINE. Occurs as a constituent of igneous rocks, sometimes forming a large part of the rock mass, over a large extent of territory in the counties of Renfrew, Hastings, Peterborough and the district of Haliburton[1]

"Grains of orange-red nepheline or elæolite are abundant with black hornblende in a white felspathic rock which is found in boulders on Pic island in lake Superior."[2]

Nepheline is also a constituent of a certain rare type of rocks which occur near Poohbah lake in the Rainy River district. These rocks have been described by Dr. A. C. Lawson.[3]

[1] Am. Jr. Science, July, 1894. Reports B. M 1897 and 1898. Reports G. S. C. 1897 and 1898.
[2] G. C. p. 480. [3] Bull. Dep. Geol., Univ. Cal., vol. i, No. 12, pp. 337-362, 1896.

NICCOLITE. Denison 12 III ; McGregor 3 A mine ; Michipicoton ; Silver Islet.

NICKEL. The chief ore of this metal in the Province is the nickeliferous pyrrhotite of the Sudbury district. Nickel also occurs in small amounts in titaniferous magnetites. See pyrrhotite.

NICKEL ARSENATE (hydrous). Denison 12 III.
G. S. C. 1892-3, p. 29 R.

NICKEL GYMNITE. Michipicoton island, in a vein cutting amygdaloid.
G. C. p. 506.

NIOBATES. See columbite.

OCHRE. Ochre occurs in different parts of the Province, the following being among some of the best known localities : Blythfield, 5 to 10, II and III ; Nassagaweya ; Nottowasaga ; Owen Sound. See also under iron ochres.

OIL. See under petroleum.

OLIGOCLASE. This felspar undoubtedly occurs as a constituent of many of our crystalline rocks, but its character has been definitely determined in only a few cases.

OLIVINE. Is found as a constituent of a number of basic rocks, such as the diabase of Sudbury.

OPHIOLITE. See serpentine.

ORTHITE. See allanite.

ORTHOCLASE. A constituent of many igneous and metamorphic rocks of the Province. Microcline is the most common form of potash felspar in our Archæan rocks. Microperthite is also of quite common occurence and is frequently mistaken for orthoclase. Good specimens of orthoclase have been obtained at the following localities : Bathurst 20 IX ; North Crosby ; North Burgess ; Sebastopol 31 XI, 23 XII. Coarse pegmatite dikes containing felspar suitable for use in pottery occur in the Kingston district and elsewhere throughout the Province.

OXALITE. Kettle Point, Bosanquet, on black shales.

PALLADIUM. See under sperrylite.

PARGASITE. High Falls and Ragged Chute on the Madawaska river ; well terminated dark green crystals embedded in greenish-white pyroxene.

SiO_2	55.05
Al_2O_3	4.50
FeO	5.85
CaO	13.44
MgO	20.95
Volatile	0.35
	100 14
Sp. gr	3.050–3.058

G. C. p. 466.

PEAT. Many years ago the late Dr. Sterry Hunt gave considerable attention to the character and occurrences of the peat deposits of the Province. He made numerous analyses and tests of the material concerning its value as a fuel. The results of his work are given in the reports of the Geological Survey for 1845-6, p. 96, 1849-50, pages 97-99, 1853-56, pages 425 to 426, and in the general report of 1863 the question of the manufacture and application of peat was discussed in considerable detail, pages 771-784.

More recently the subject of peat has again attracted considerable attention and has been treated of in some of the reports of the Bureau of Mines, 1891, pages 206 to 210, 1892, pages 195 to 220, 1894, pages 32 to 34, 1896, pages 185 to 192, and in the publications of the Geological Survey. The chief occurrences of the material are given in these reports.

PECTOLITE. McKellar's (Cathcart) point, lake Superior.

PENTLANDITE. Drury 2 II, Worthington mine, and other places in the Sudbury district.

Am. Jr. Science, 1893, p. 493.

PERISTERITE. "This beautiful variety of albite exhibits a peculiar bluish chatoyancy or opalesence, sometimes mingled with pale green and yellow, and called 'moonstone.' It is found in crystals and by the ton in large cleavable masses, containing disseminated grains of quartz in veins cutting the Laurentian strata at Bathurst (19 IX), also in crystals on the north side of Stony lake, near the mouth of Eel creek, in Burleigh, in large opalescent cleavable masses of reddish albite, and on the 9th line or concession north of Perth on the land of Robert McEwen. This beautiful material is especially adapted for use in the arts."[1]

The following is an analysis of a specimen from the Bathurst locality by Dr. Sterry Hunt :

SiO_2	66.80	Fe_2O_3	0.30
Al_2O_3	21.80	Ignition	0.60
K_2O	0.58		
Na_2O	7.00		99.80
CaO	2.52	Sp. gr	2.625
MgO	0.20	H	6.

The material also occurs in Bromley.

[1] G. F. Kunz in G. S. C. 1887-8, p. 75 S. [2] G. S. C. 1850, p. 36.

PERTHITE. Cameron 7 B ; Dungannon 20 X ; North Burgess 4 VI.

	I.	II.		I.	II.
Si O_2	66.44	66.50	K_2 O	6.37	6.18
Al_2 O_3	18.35	19.25	Na_2 O	5.56	5.56
Fe_2 O_3	1.00		H_2 O	0.40	0.44
Ca O	0.67	0.56			
Mg O	0.24	0.24	(Ignition)	99.03	98.73

Hunt, G. S. C. 1850, p. 36.

PETALITE. "Petalite is here mentioned among the minerals of Canada upon the authority of Dr. Bigsby, according to whom this mineral was found, with tremolite, in a large boulder on the lake shore at Toronto."

G. C. p. 481.

PETROLEUM. This substance is found in different Palæozoic limestones in small quantities filling cavities in corals and other fossils. It also occurs in the shales of the Utica formation. A spring carrying some of the material rises through these rocks on the Grand Manitoulin island. Utica shale when freshly exposed can often be caused to burn on the surface. These shales, at one time, before the discovery of oil wells in the Province, were used for the distillation of petroleum. The shales of Collingwood gave 4 to 5 per cent of oily matter. The Devonian shales of Kettle point by experiment on a small scale gave 4.2 per cent of crude oil, together with a portion of ammoniacal water. The oil fields of Ontario are situated in the territory lying between the southern point of lake Huron and the northwestern shore of lake Erie. Full accounts of these fields are given in the reports of the Bureau of Mines and Geological Survey.

B. M. 1895, pages 21 to 29. G. S. C. 1866, pages 233 to 262 ; 1890-91, pages 1 to 94 Q.

PHLOGOPITE. This is the mica of commerce in Ontario, and is generally called amber mica on account of its color. It is of frequent occurrence in association with the crystalline limestones and pyroxenic gneisses of the Laurentian. Apatite and phlogopite both occur in economic quantities in some deposits. North Carolina and India are producers of white mica, but as yet very little of this variety of the mineral has been produced in Ontario, although there is evidence that it occurs in economic quantities in some localities. The following is an analysis of phlogopite from North Burgess, which township lies in the chief mica producing district of the Province :

SiO_2	40.97	Na_2O	1.08
Al_2O_3	18.56	Volatile	1.00
FeO / Fe_2O_3	none.	Loss, which is probably fluorine	4.33
MgO	25.80		
K_2O	8.26		100.00

G. C. p. 45.

PHOLERITE. "Occurs in the form of white unctuous films in the joints of many quartzose sandstones of the Huronian series ; and what appears to be the same mineral is occasionally met with in small botryoidal masses lining cavities in the Jasper conglomerate of the same series."

G. C. p. 495.

PICROLITE. Ross 8 IX.

G. S. C. 1882-3-4, p. 14 L.

PLAGIOCLASE. See albite, oligoclase, andesine, labradorite, bytownite and anorthite.

PLATINUM. See sperrylite.

PLUMBAGO. See graphite.

POLYCRASE. Calvin.

G. S. C. 1897, p. 61 I.

POLYDYMITE. Denison 5 IV, Vermilion mine ; Drury 2 II.

PREHNITE. "Prehnite is associated with native copper and calcite in the lake Superior region, Michipicoton, etc., where it is often of a rich green color in spherical masses of crystals an inch across, or in aggregations even larger, affording a curious but pleasing green stone resembling a chrysoprase."[1]

It sometimes forms distinct veins in the trap rocks, as on Slate river, an affluent of the Kaministiquia.

SiO_2	43 41	H_2O	4 14
Al_2O_3	23.80		
Fe_2O_3	1.26		99.76
Mn_2O_3	0 53	Sp. gr	2.88
CaO	26.62		

[1] G. S. C. 1887-8, p. 77 S. [2] Chapman Min. and Geol. p. 111, and Can. Journal, 1870, p. 267.
See also chlorastrolite.

PYRALLOLITE. See rensselaerite.

PYRITE.—Good cabinet specimens of this widely distributed mineral are found at numerous places in the Province. The mineral is frequently auriferous, and in some cases has been found to carry nickel and cabalt. Deposits of it have been developed to some extent with the object of securing a supply of the material for use in the manufacture of sulphuric acid, for which it is in considerable demand. These deposits are situated in the townships of Darling and Elizabethtown and, near Schreiber on the Canadian Pacific Railway. There are no doubt numerous workable deposits in the Province. Bedford, Devil's lake ; Big river, a tributary of the Opazatika[1] : Darling 5 IV ; Elizabethtown 19 II ; Hungerford ; Graham 12 III ; Madoc 11 XI[2] ; near Schreiber station on the C.P.R. ; Nickel lake, Rainy River district ; lake Temagami, Nipissing district.

B. M. pp. 255-6, 1895. [2] G. S. C. p. 106, 1866. B. M. p. 74, 1894.

PYROXENE. There are a large number of localities in the eastern crystalline area of the Province in which large well formed crystals of this mineral are to be found. Bathurst 20 IX ; Bedford, Toomah bay ; Carlow ; Herschel 3 IV ; North Burgess 2 IX ; Sebastopol 23 XII and Turner's island in lake Clear. See also augite, diallage, hypersthene, ægirine, etc., etc.

PYRRHOTITE. Through the replacement of some of the iron in pyrrhotite by nickel it becomes the ore of this metal in the Sudbury district. The deposits are claimed by most authorities to be of igneous origin. Pyrrhotite is found occuring in large masses in other parts of the Province, especially in the east, but in these cases it carries little nickel. In these deposits the mineral appears to be of aqueous origin The map of the Sudbury district which accompanies this annotated list of minerals shows the location of the chief deposits of pyrrhotite in the vicinity of Sudbury, and it is not necessary to refer further to the localities. Some of the chief localities in which non-nickeliferous pyrrhotite occurs are the following : Dalhousie 22 II, 18 III[1] ; Elizabethtown 19 II ; Galway ; Monteagle ; Madoc 10 II ; Olden ; Wollaston 15 II, 22 IX. The following are the averages of the analyses of copper-nickel ores from one pro-

[1] G. S. C. 1897.

perty in each of five townships in the Sudbury district, the percentage given in each case being the average of several analyses :

	Nickel.	Copper.
1	2.62	0.78
2	2.62	0.13
3	2.99	0.30
4	1.94	0.62
5	2.26	2.80

QUARTZ. In addition to the occurrence of this mineral in irregular forms as a rock and vein constituent, it has been found at numerous localities in crystals. Bruce Mines ; Madoc IX; Thunder Bay. See also amethyst, agate, jasper, chalcedony and chert or hornstone, smoky quartz at Thunder bay and elsewhere. Some of the quartzites, such as those on the north shore of lake Huron in the vicinity of Killarney consist entirely of pure quartz and are adapted to most purposes for which quartz is required.

RAPHILITE. Bathurst 26 XII ; Dalhousie ; Bedford.

G. S. C. 1892 p. 69 A.

RENSSELAERITE. Charleston lake, coarsely columnar radiating variety.[1]

SiO_2	61.90
FeO	1.45
MgO	30.42
H_2O	6.54
	100.31
Sp. gr	2.644

Ramsay 8 VI. "It is on the east side of the lot towards the front and runs in a general way with the length of the lot. It appears to be between a bed of quartz on the one hand and crystalline limestone on the other, and considerable masses might be obtained from it." It is economically applicable to the purposes for which soapstone is used and several others besides. Being of a tougher nature and not liable to exfoliate, it is more durable and receives a higher polish.[2]

[1] G. C. p. 471. [2] G. S. C. 1856 p. 44.

RHODIUM. See under sperrylite.

RHODOCHROSITE. Silver Islet and McKellar island, lake Superior.

ROCK SALT. See salt.

RUTILE. "Rutile in delicate acicular crystals has been observed in drusy cavities, with quartz, at the Wallace mine on lake Huron."[1]

"In the vein on the coast near the mouth of the Spanish river, rutile occurs in delicate acicular crystals."[2]

Madoc, Green island, Moira lake.

Minute grains of rutile also occur with the black magnetic sands on the shores of lakes and rivers.

[1] G. C. p. 502. [2] G. S. C. p. 63; 1848-9.

SALT. Halite, commonly known as "salt," occurs in the strata underlying a considerable area in the western part of the Erie and Huron peninsula, and is present in appreciable amounts in many mineral springs. Strongly saline waters have been met with in drilling for gas in places in eastern Ontario.[1]

The following is an analysis of a salt produced at Seaforth :[2]

NaCl	98.2778
$CaSO_4$	1.2515
$MgCl_2$	0.0078
H_2O	0.6832
Insoluble	0.0160
	100.2363

[1] R. Com. pages 181 to 191. G. S. C. 1869 p. 211, and 1874-5 pages 267 to 300.
[2] Cat. Ec. Min. Can., Phil. Int. Ex. 1876.

SAMARSKITE. Lyndoch ?

SAPONITE. In some of the silver veins of the Port Arthur district, e.g. Beaver mine.

SAUSSURITE. This secondary aggregate is found in many rocks, e.g., the saussurite gabbro of the Rainy River district.

SCAPOLITE. Good crystals of large size are frequently found in mica and apatite deposits. The mineral also occurs as an essential constituent of certain gneisses in the eastern part of the Province. These scapolite gneisses frequently form one wall of some of the magnetite deposits. See also under sphene.

Can. Rec. Science 1889 p. 198. B. M. 1898 p. 229.

SCHORL. See tourmaline and indigolite.

SELENITE. Haldimand county, Mount Healy ; Moose river ; Niagara Falls. The mineral also occurs sparingly in certain mineral deposits in the Archæan rocks, e.g., in the apatite deposit of the Foxton mine, Frontenac county. See also gypsum.

SELENIUM. A trace of selenium is said to be present in a galena which is found in a vein near the mouth of Black river, lake Superior.

SERICITE. This mica occurs in metamorphic rocks, such as the sericite schists of the north shore of lake Huron.

SERPENTINE. This mineral is found quite widely distributed among the older crystalline rocks. It sometimes forms rock masses and is frequently mixed through crystalline limestone the two forming together a fine decorative material.

Some interesting notes are given by Lawson on the serpentines of the Rainy River district in the Report of the Geological Survey for 1887-8 pages 45, 50, 97, 98 and 180 F.

In eastern Ontario the mineral is often associated with the so-called eozoon limestones. It is also found in smaller amounts in some of the iron ore beds of Belmont and Marmora ; Bedford 6 III ; North Burgess 2 VIII ; Marmora 13 IX ; Rainy Lake district, at the south end of lake Despair and the north end of Clearwater lake.

B. M. 1891 p. 81, 1894 pages 73, 76, 93. G. C. pages 471 to 473.

SIDERITE. Elizabethtown ; Lake Superior ; Marmora ; McIntyre.

SILLIMANITE. In Hastings county as a constituent of crystalline schists. See also fibrolite.

SILVER. This metal is found in the native state in a number of deposits in the Port Arthur district. A somewhat detailed description of these deposits is given in the Report of Geological Survey for 1887-8, pages 5 to 131 H and pages 88 to 96 S. "The Story of Silver Islet" will be found in the Report of the Bureau of Mines for 1896, pages 125 to 158. Silver is also present in some of the galena of the Province, as in that of the township of Barrie, which is associated with a number of other metallic minerals. Quite recently a sample, consisting of galena, sphalerite and pyrite. obtained from a vein in the crystaline limestone in the township of Olden, was assayed in the laboratory of the Kingston School of Mining and found to contain 22 oz. of silver to the ton. See also argentite.

SMALTITE. McKim; Madoc 2 II; Dominion iron mine.

G. S. C. 1895, p. 129 A.

SOAPSTONE. See steatite.

SODALITE. Dungannon 29 XIII, and other localities in the counties of Hastings, Renfrew, Peterborough and the district of Haliburton in nepheline-bearing rocks, frequently associated with corundum.

SPERRYLITE. Vermilion mine, township of Denison. An analysis of the mineral, from this deposit, made by Prof. H. L. Wells of Yale, gave the following results :

As	40.98
Sb	0 50
Pt	52 57
Rh	0.72
Pd	trace
Fe	0.07
SnO_2	4.62
	99.46

Small amounts of platinum also occur in some of nickel-copper ores of the Sudbury district, and it is probable that the metal occurs in these in the form of sperrylite.

Am. Jr. Science, vol. 37, p. 67, 1889 ; B. M. 1892, pages 179 to 180.

SPHALERITE. This mineral is found widely distributed in veins and in limestone rocks and is usually associated with galena. It occurs in grains scattered through crystalline limestone in many places, and also in veins in the same class of rocks. "It occurs in some of the veins on lake Superior, as at Mamainse and at Prince's mine, where it is abundant with copper glance and native silver. . . Blende is also occasionally met with in small masses of a honey-yellow color, imbedded in the limestones of the Trenton group at Kingston. . . and in the dolomites of the Niagara formation in the west. At Niagara Falls it sometimes appears to replace fossils ; and at other times occurs in beautiful wax-yellow cleavable masses imbedded in nodules of gypsum."[1] The larger deposits of the mineral hitherto discovered are situated in the Port Arthur region. Balfour 6 I ; Barrie 5 to 9 IX ; Blende lake, Thunder Bay district ; Dorion 10 VI ; McKellar island ; McIntyre, Shuniah mine ; Paresseux rapids, Kaministiquia river ; Point aux Mines, lake Superior ; Silver lake, Thunder bay ; White Sand river, Zenith mine ; Marmora 1 XI.

[1] G. C. p. 514.

SPHENE. This mineral is of quite common occurrence among the crystalline rocks of eastern Ontario. "Dr. A. E. Foote described a new locality for sphene and associated minerals at Eganville, Renfrew county, Canada. The sphene occurs in immense crystals, weighing from 20 to 80 lb. in a vein of apatite 20 feet wide. Many other veins of smaller size occur in the same county. The rock is primary gneiss and granite. A solid mass of sphene, very highly cleavable, 5 x 2 x 2 feet, was observed in the side of the vein. It yielded several hundred pounds of sphene. Close to it doubly terminated crystals of scapolite, weighing from 12 to 30

lb., were found. Phlogopite and zircons, some of them twinned, occur at the same locality. From the enormous size of all the crystals found in this county it must take rank as one of the most remarkable mineral localities known. When the vein 20 feet wide, spoken of above, was discovered, a doubly terminated crystal of apatite, weighing 500 lb. and bright upon the surface and ends, was said to have been found."[1] See also under titanite.

[1] Pro. Min. Section, Ac. Nat. Sciences, Philadelphia, Sep. 27, 1880.

SPINEL. "On the tenth lot of the first range of Burgess the flesh-red Laurentian limestone abounds in crystals of black spinel, which may be traced over an extent of a mile or more. The crystals are sometimes an inch or even two inches in diameter, and are occasionally coated with mica, though often brilliant, and exhibiting a replacement of the edges of the octahedron." Ross township, in imperfect crystals with fluor-spar and apatite in crystalline limestone. The mineral is also found at numerous other localities in the Laurentian. See also gahnite.

SPODUMENE. " . . in a small rolled mass of granite near Perth."

STAUROLITE. "According to Dr. Bigsby . . . it occurs in the gneiss to the north of lake Superior . . . where it is abundant in very small crystals on Rainy lake and in much larger crystals on the river Lacroix, at the second portage from the lake of the same name."

G. C. p. 498.

STEATITE. Blythfield; Clarendon 14 II; Elizabethtown; Elzevir; Grimsthorpe; Kaladar 5 I; island in Rideau lake; Thunder bay. See also rensselaerite.

STEPHANITE. Badger mine, Port Arthur district.

STIBNITE. Is said to occur near Echo lake and Garden river.[1] Barrie 21, 22, 23 VIII; Marmora; Sheffield 28 I.

[1] R. Com. p. 30.

STILBITE. "This mineral with heulandite and chabazite is said to occur in some of our trappean rocks, but nowhere in distinct and well characterized examples."

Chapman, Min. and Geol. p. 112.

STILPNOMELANE. Madoc 12 V, variety chalcodite.

STRONTIANITE. Nepean 31 A.

CO_2	30.54
SrO	65.43
CaO	3.38
Insoluble	0.17
	99.52
Sp. gr. at 15° C.	3.704

G. S. C. 1892-3, p. 23 R.

SULPHUR. This substance occurs sparingly in the simple state in the Province; chiefly as an efflorescent crust on decomprising pyrites. It is also at times deposited as an incrustation around springs, as in Charlotteville 3 XII. It is also found in the form of minute crystals and in earthy coatings on some of the thin bedded limestones around Niagara Falls and elsewhere. Denbigh 3 V, in quartz from pyrite;[1] North Burgess 2 V.[2]

[1] G. S. C. 1892-3, p. 27 R. [2] G. S. C. 1896 R.

SYLVANITE. Moss H 1, Huronian mine.

TABULAR SPAR. See wollastonite

TALC. Blythfield, near Calabogie lake; Clarendon 24 II; Elizabethtown, near the town of Madoc; Kaladar 8 I; Grimsthorpe 8, 9, 10 V. See also steatite.

SiO_2	60.45	MgO	29 84
Al_2O_3	0.27	H_2O at 100° C.	0.32
Fe_2O_3	0.78	H_2O above 100° C.	5.42
FeO	2.04		
NiO	0.50		99.78
CaO	0.16	Sp. gr. at 15° C	2.65

G. S. C. 1892-3, p. 18 R. B. M. 1893, pages 99 to 102.

TANTALITES. See columbite.

TELLURIUM. This element occurs in two Ontario minerals, namely, sylvanite and hessite, the localities of which have already been given.

TENNANTITE. Barrie 6, 7, 8, 9 IX.

TETRAHEDRITE. Silver Islet; Madoc, Empire mine.

G. S. C. 1866-9, p. 168.

THOMSONITE. "Thomsonite of red color, compact and fibrous, often banded with green in a number of concentric rings, is found on the northern shore of lake Superior. . . . The pebbles vary in size from one-eighth of an inch up to one inch across, and are quite extensively sold on all sides of the lake as an ornamental stone. The pebbles when polished find a ready sale among tourists who visit that region. The green which Peckham and Hall described as lintonite, an uncrystalline green variety of thomsonite, often forms the centre or band,

making an effective gem stone, and is sold for the same purpose." Gargantua and Point Mamainse.

G. S. C. 1887-8, p. 78 S.

TIN. This metal occurs as the oxide associated in small quantities with sperrylite in the Vermilion mine, Denison. Specimens of cassiterite have been collected by Mr. G. R. Mickle and others in the vicinity of lake Wahnapitae. Tin also occurs in small amounts associated with the mineral columbite from the township of Lyndoch.

TITANITE. This mineral has already been referred to under the name of sphene. As the following note is of some economic interest, and is written by the well-known gem expert, Mr. G. F. Kunz, it was thought well to add it here.

"The titanites of Canada have a world-wide reputation, not only for their color, polish and the perfection of the crystals, but also for their great size. A twin crystal of this mineral has been found on Turner's island, in lake Clear (Sebastopol), weighing 80 lb. They are found abundantly in this region, associated with apatite. The crystals are generally of such deep brown color as to appear black, and it is rare that even a small transparent gem could be cut from them. As crystals, however, they are unexcelled, and many thousand dollars' worth have been sold as specimens. The finest are in Renfrew county, especially in Sebastopol and Brudenell townships. Yellow crystals have not been observed as yet."

G. S. C 1887-8, p. 77 S.

TITANIFEROUS IRON ORE. See under magnetic.

TITANIUM. As a constituent of certain iron ores this element occurs abundantly in the Province. It is also a constituent of sphene.

TOURMALINE. Occurs in many localities among the crystalline rocks. "Fine crystals, rich yellowish or transparent brown in color, often occur imbedded in a flesh-red limestone, . . . in the township of Ross. . . These furnish an occasional gem."[1] Black tourmaline or schorl is found at a large number of localities, some of which are the following: Charleston lake, Leeds county; Blythfield, near High Falls; Bathurst 18 IV, "Crystals are met with [here] an inch in diameter, having finely modified terminations [2]"; Yeo's island, one of the Thousand islands; Madoc; North Elmsley; Ross 27 III. See also indigolite.

[1] G. S. C. 1887-8, p. 67 SI. [2] G. C p. 492.

TRAVERTINE Oneida, with gypsiferous rocks. See also calcareous tufa.

TREMOLITE. Abundant in crystalline limestone, as in the vicinity of the village of Sharbot lake, and elsewhere.

In the report of the Geological Survey for 1898, p. 53 R, the following localities are mentioned: Bathurst 26 XII; Blythfield 22, 23 IV; Clarendon 37 VII; Ross 23 IV. Good specimens also come from Bagot, Lake and North Burgess.

TURGITE. Madoc; North Burgess.

URACONITE. See uran-ochre.

URALITE. This substance, which is of secondary origin, is recognized in many rocks.

URANITE. See uran-ochre.

URANIUM. See uran-ochre and coracite.

URAN-OCHRE. Madoc 11 V, the mineral lines fissure in magnetic iron ore; Snowdon, lining minute cavities in magnetite. Uranium is also present in other magnetites, non-titaniferous, in eastern Ontario.[1] See also coracite.

[1] B. M. pp. 232-3, 1897.

VANADIUM. Occurs in small amounts in titaniferous magnetites.

VESUVIANITE. Is found in crystalline limestones in different places in the eastern part of the Province. Bedford; Clarendon.

WAD. Madoc 4V; Thunder bay, northeast shore, mixed with iron ochre.

Fe_2O_3	33.68	H_3PO_4	trace
Mn_2O_3	16.54	H_2O	3.82
MnO	5.08	Rock matter	36.12
CaO	0.81		
CO_2	3.78		99.83
H_2SO_4	trace		

Chapman Min. and Geol., p. 88.

WATER. See mineral waters.

WERNERITE. See scapolite.

WHARTONITE. Blezard 2 II.

The nickel-bearing minerals blueite, folgerite and whartonite were so named by S. H. Emmons. Journal Am. Chem. Soc. vol. xiv, No. 7 and B. M., 1892, pages 167 to 170. See also Am. Jr. Science, 1893, p. 493.

WILSONITE. Bathurst.

SiO_2	47.50	Na_2O	0.82
Al_2O_3	31.17	H_2O	5.50
MgO	4.25		
CaO	1.51		99.97
K_2O	9.22		

The mineral also contains traces of manganese, to which its color is probably due.[1] North Burgess 2 IX ; Foxton mine, Frontenac county ; and numerous other localities. "Wilsonite is found . . . in masses of some size, associated with scapolite. The specimens are beautiful, the minerals often passing into each other. The rich purplish-red color of this mineral, and the fact that it admits of a good polish, make it one of the most interesting of gem stones." [2]

[1] G. C. p. 483. [2] G. S. C. p. 79S, 1887-8.

WITHERITE. Gillies, Porcupine mine.

WOLFRAMITE. The only occurrence of this mineral known in Ontario is that in which it was fonnd by Prof. E. J. Chapman in a boulder of gneiss on the shore of Chief's island, lake Couchiching, near Orillia. The mineral was associated with magnetite.

Tungstic acid	73.45	Silica	0.20
Niobic acid (?)	1 95		
Ferrous oxide	9.05		100
Manganous oxide (by difference)	15.35	Sp. gr	6,938

Can. Journal, 2nd series, vol. i. 308, and vol. v. p. 303.

WOLLASTONITE. Fibrous wollastonite occurs in many of the crystalline limestones in eastern Ontario, mixed more or less intimately with mica. pyroxene, quartz and other minerals. North Burgess.

XENOTIME. Calvin.

G. S. C., 1896, part R.

YENITE. See lievrite.

ZEOLITES. Minerals of this group are found in well defined specimens in the amygdaloidal traps of lake Superior, and in a few other places in the Province. They also occur as microscopic individuals in many rocks.

ZINC. See under sphalerite.

ZINC BLENDE. See sphalerite.

ZIRCON. The twin zircons of the township of Sebastopol are well known, and some specimens have sold for high prices. Brudenell ; near the village of Bancroft, in nepheline syenite ; Pic island, lake Superior, in a syenite rock ; Sebastopol 31X, twin zircons. This last locality is referred to by W. E. Hidden in the Am. Jr. Science, June, 1881, and by A. E. Foote in Proc. Min. Section Philadelphia Ac. Nat. Science, Sept. 27, 1880, and Jan. 24, 1881.

ZOISITE A secondary constituent in many rocks.

ZONOCHLORITE. "It occurs in small rolled masses and in the rock at Nipigon bay, and was described by Dr. A. E. Foote. It is a dark opaque green stone, beautifully marked and veined, and admitting of a high polish, and ought to find some sale as a local or tourists' gem."

G. S. C., 1887-8, p. 77S.

A SKETCH OF THE NICKEL INDUSTRY.

By J. W. Bain.

During the past ten years Canadians have awakened to the fact that, together with mines of gold, silver, copper, lead, zinc and iron, they possess valuable mines of nickel—one of the less common metals—and have discovered at the same time that only in one other part of the world are to be found large stores of this metal. Public enlightenment has been due to an amendment of the Mines Act, which aims to provide for the refining of all domestic nickel ores in Canada. At present the ore is mined and simply concentrated before export, and the reduction of the crude nickel to fine metal is conducted almost entirely in the United States. There has been a good deal of discussion in the columns of the daily press, as may well be supposed, over the taxation on crude nickel, and the editorial deliverances have been reinforced by a series of controversial letters from some of those who are financially interested in the affair. Information on the subject is scarce and not easily accessible, and in view of the discussion which has been carried on the following outline of the metallurgy of nickel may be interesting and useful.

SOURCES OF NICKEL ORES.

Nickel has been discovered in greater or less abundance in many parts of the world, but only the more prominent deposits can be mentioned here. Small quantities of the arsenides and sulph-arsenides of nickel are found in some of the well known metalliferous lodes of Germany and Hungary. As a rule, the nickel may be regarded as a bye product in the reduction of these ores, although a valuable one, and the proportion of the metal to the rest of the ore is very low. Norway, Italy, the United States and Canada possess deposits of nickel sulphides, the Canadian only being sufficiently valuable to work.

The Norwegian deposits, consisting of nickeliferous pyrrhotite and pyrite, are found chiefly at the contact of massive gabbro with schists. The ore bodies are almost pure pyrrhotite surrounded by gabbro impregnated with the sulphides which, in passing outwards, gradually decrease in amount until finally they disappear. There are small bodies of rich ore averaging 7 per cent. nickel, and the better mines can get 3.5 to 4 per cent., but the grade of the bulk is much lower. In 1870 miners were satisfied with 0.5 to 1.3 per cent. nickel from the smelting ore, but in later years, when only rich mines have been operated and hand sorting has been practised with more care, the yield has increased from 1.4 to 2.5 per cent., averaging 2 per cent.

For a number of years a considerable quantity of ore was mined, which reached a maximum in 1876 with a product of 42,550 tons. Since then the following quantities of pure nickel have been produced :

1876	360 tons.
1877–80	100 "
1881–85	125 "
1886-92	105 "

At Lancaster Gap, Penna., there is a deposit of nickeliferous pyrrhotite which was worked for a number of years, commencing in 1862, by Joseph Wharton of Philadelphia. The ore is reported to have carried 1.5 to 3 6 per cent. nickel and 0.75 per cent. copper; a considerable quantity of nickel was produced, aggregating, it is said, 2000 tons. The mine has not been operated for some time.

Nickel silicates are found in New Caledonia, and in Oregon and North Carolina, United States. The latter deposits are small and give no promise of future development; as far as can be gathered, the total quantity of ore which could be mined is insignificant.

The presence of nickel in New Caledonia was pointed out by Garnier in 1867, but not until 1873 were the mines opened and shipments made. Geologically, the southern and eastern portions of the island are large areas of massive serpentines, in the centre of which occur the deposits of nickel. In the serpentines are found depressions filled with large bodies of clay, which have probably been formed by the decomposition of the surrounding rocks The presence of nickel is explained in the following way : After the formation and hardening of the clay, springs broke out which corroded the serpentines at their contact with the clay, and in these channels were then deposited from solution iron and nickel ores. Whether this be the true explanation or not, the nickel ore is always found at or near the contact of the clay with the enclosing serpentine, either in pockets or in small veinlets (stockwork) traversing the mass in all directions.

The ore is a hydrous silicate of nickel and magnesium known as garnierite, of a beautiful apple-green colour when pure. It is said to average 10 per cent. nickel after sorting, with serpentine as gangue. There are two companies operating: Le Nickel, and Le Société d' Exploitation de Mines de Nickel. The former, which is the larger, has smelters at Havre and buys all the nickel ore produced in New Caledonia. A large English company has recently entered the field.

The mining is carried on in a rather crude fashion, mainly by large quarries. The ore is simply broken down after the covering of red clay has been carefully stripped, and then sorted by hand into rich and poor qualities—the former containing 8 per cent. of nickel and over, the latter less. The waste, still containing 3 to 4 per cent. nickel, is thrown aside as worthless. Where much red clay is found the ore is washed, but this can only be done roughly on account of the loss which takes place. Some of the larger veins in hard rock are worked by incline and overhand stopes, but the walls are irregular and may easily be lost in driving levels. The ore is transported usually to the seaboard by aerial tramways and by carts, at a cost varying from 10 cents to $2.00 per ton. The mines are all situated within a few miles of the sea so that no long hauls are necessary, but shipping facilities are poor. Those deposits which lie far inland are not worked at all. The ore is carried for ballast very cheaply by vessels during the wool-shipping season.

A mining engineer who is familiar with the country states that "European buyers generally pay about 75 centimes per kilo (6½ cents per pound) nickel contained in the ore (with a minimum of 7 per cent.), delivered in barges alongside the loading vessel. Freights by sailing vessels vary from 32 to 34 shillings ($7.78 to $8.26) per ton to Glasgow, Havre or German ports. Provided a minimum of 7 per cent. has to be maintained, I doubt very much whether the production will exceed 60,000 to 70,000 tons per annum, but with a lowering of the nickel contents to say 5.5 per cent, the production could be more than doubled."

The Engineering and Mining Journal of May 20, 1899, notes that a cargo of 3000 tons New Caledonia ore is being sampled for the Orford Copper Co., the ore averaging 7 per cent. nickel. The cost f. o. b. in New Caledonia was 30 shillings ($7.50) per ton, and the freight to England 38 shillings ($9.50), so that the total cost would be about $17 per ton in New York.

Some of the miners are Englishmen at $1.20 to $1.80 per day, others are Kanakas at $4 00 per month and board, but the majority are convicts obtained from the Government on contract.

	Production (metric tons).	Exports.
1890	32,000	......
1891	33,000	......
1893	69,614	45,614
1894	61,243	40,089
1895	29,623	38,976
1896	6,417	37,467
1897	29,464	57,439
1898	74,614	74,614
1899	.....	10[illegible],908

Returning to our domestic supply, we find that a body of copper ore was discovered in a railway cutting during the construction of the C.P.R., about four miles northwest of the town of Sudbury. The district is exceedingly rough, and, before the advent of the railroad, accessible only with difficulty, so that the prospectors and explorers had either been deterred by the magnitude of the task of exploration or had thought that valuable deposits of ore probably did not occur. When the first discovery had been made, however, others followed in rapid succession, and before long several companies were at work. One of these, the Canadian Copper Co., shipped a car load of their ore to be smelted, and it was then discovered that nickel was present in such quantity as to make the ores far more valuable for that metal than for copper. A sketch of the growth of the industry from these beginnings would form a lengthy paper, and it can only be said that the growth has been rapid, yet of that solid character which is of so much importance to the country at large.

The ores themselves are either chalcopyrite or pyrrhotite, or far more commonly a mixture of these two. The chalcopyrite is often found of a fair degree of purity in pockety masses in the mixed ore, while vast bodies of pyrrhotite with little or no chalcopyrite are found here and there in the district. Associated with these common minerals

are small quantities of those which contain nickel as an essential constituent, such as millerite, pentlandite and others which contain large percentages of the metal and thus raise the general richness of the mass. The nickel appears to be present in the pyrrhotite of these ores replacing some of the iron; it is variable in quantity, but usually forms about three per cent. of the ore. Occasionally richer masses, in which may be discovered often the nickel minerals above mentioned, are found yielding as much as eight or nine per cent, but these bonanzas are not very common. The smelting ore during the last seven years has averaged 2.51 per cent. nickel and 2.92 per cent. copper.

The world's production of nickel in metric tons is shown as follows for the last seven years, as published in volume VIII of the Mineral Industry.

Year.	New Caledonia.				Ontario.	Norway.	United States.		World's total.	Ontario's percentage of total.
	Prussia.	France.	England.	Total.			Domestic.	Imported.		
1893..	893	1,600	....	2,493	1,807	113	11	1,320	4,424	40.8
1894..	522	1,545	355	2,422	2,226	103	4	1,920	4.755	46.8
1895..	698	1,545	305	2,548	1,764	17	5	1,220	4,334	40 7
1896..	822	1.545	406	2,972	1,541	16	8	1,685	4,537	33.9
1897..	898	1,245	715	2,858	1,813	nil	15	1,859	4.686	38.7
1898..	1,108	1,540	960	3,608	2,503	(a)	5	3,234	6,116	40.8
1899..	(a)	(a)	(a)	(a)	2,605	(a)	10	3,651	......	.. ..

(a) Statistics not yet reported.

The following table gives in metric tons the nickel production of Ontario for six years, according to the reports of the Bureau of Mines and of the Geological Survey, but there are discrepancies in the figures of the first three years.

Year.	Reported by Ontario Bureau of Mines.	Reported by Dominion Geological Survey.
1894	2,331	2,226
1895	2,099	1,764
1896	1,766	1,541
1897	1,813	1,813
1898	2,525	2.503
1899	2,605	2,605
Total	13,139	12,452

REFINING NEW CALEDONIA ORES.

A number of methods for the extraction of nickel from these ores have been tried at various times and places Garnier, who has taken a prominent place in connection with this industry, endeavored to smelt the ore directly to a nickeliferous pig iron which would afterwards be refined in reverberatory furnaces. Difficulties in the last stage, however, led to the abandonment of the process. Wet methods varying slightly in detail have been used in several metallurgical works; these follow on a large scale the operations of a chemical analysis. The ore is dissolved in acids, the other metals are successively removed by treatment with such materials as lime and bleaching powder, and finally a solution containing only nickel is obtained. From this it is easy to produce the metal by fusing with charcoal the dried nickel salt. The method which I believe is used at present is a dry one and may be described as follows:

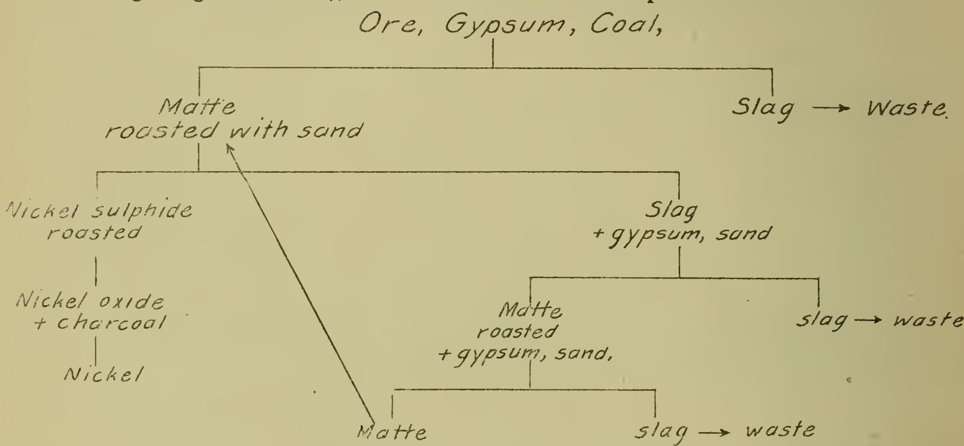
The ore is mixed with gypsum and coal and smelted in low water-jacketed furnaces with the formation of a nickeliferous matte and a slag which is allowed to go to waste. It will be remembered that the ore consists of iron and nickel oxides, magnesia and silica, and in the smelting operation just described the following changes take place. The gypsum, which contains lime and sulphur, is decomposed and gives up its sulphur to that element which is most ready to receive it, in this case to the nickel. After the nickel has satisfied itself with sulphur the remainder is taken up by part of the iron, while silica, magnesia and lime unite with the rest of the iron to form a slag. We have then a mixture of iron, nickel and sulphur, or iron-nickel matte, which by reason of its greater sp. gr. sinks to the bottom of the furnace through the lighter slag, which contains practically none of the valuable metals and is thrown away.

The matte is now roasted and a portion of the sulphur driven off; on smelting with sand the nickel once more appropriates as much sulphur as it requires, leaving the rest to

the iron. Since part of the sulphur has been removed it is plain that the nickel will have the lion's share, and that only a small proportion of the iron will be able to satisfy itself with sulphur. The remainder of the iron unites with the sand to form a slag. We have again a matte, this time very much richer in nickel and poorer in iron, and a slag containing only a small percentage of nickel.

By a repetition of these operations the iron is finally removed, leaving a compound of nickel and sulphur, which is roasted with nitrate of soda to produce nickel oxide. The latter is then mixed with charcoal and exposed to intense heat, resulting in the production of metallic nickel.

The diagram given below gives a concise view of the operations.



SMELTING CANADIAN ORES.

The Canadian ores, consisting of chalcopyrite and pyrrhotite with accompanying rock matter, are treated at Sudbury in the following manner :

The ore after coarse crushing is piled in a special manner in heaps upon a foundation of wood; the wood is then fired and almost immediately the sulphur in the ore commences to burn and continues to do so without any further addition of fuel. These piles hold from 600 to 3,000 tons of ore and burn from 6 to 20 weeks, reducing the sulphur contents roughly from 30 to 7 per cent. The roasted ore is then taken to the smelters, which are of the Herreshof pattern, water jacketed and 9 feet high to the charging door. Two furnaces are always in operation, each with a capacity of 125 tons of ore and producing 15 tons of matte per day of 24 hours. Beside each furnace is placed a forehearth or settler into which the matte and slag flow as soon as they are fused in the furnace. There is thus obtained a more complete mechanical separation; a comparatively quiet pond is formed in which the matte can settle to the bottom, while the slag flows continuously over a spout at the top of the well. The matte is tapped at short intervals into conical pots which are wheeled out into the open air to cool. The slag is exceedingly basic and flows with perfect liquidity until, pouring from the slag spout, it meets a powerful jet of water which granulates and sweeps it away to the dump.

In order to understand these operations, it may be well to glance very briefly at the chemical reactions upon which they are based. When the ore, a mixture of iron, nickel, copper and sulphur with silica and rock matter, is roasted in the open air a large portion of the sulphur burns to sulphur dioxide and passes off into the atmosphere; the iron having lost most of its sulphur supplies the vacancy with oxygen from the air, forming oxides, while that portion of the sulphur which it still retains is combined as iron sulphates. The behaviour of the copper and nickel is somewhat similar, but so strong is the affinity of these metals for sulphur that only small portions are changed to oxides, the bulk being sulphates. The gangue is from a chemical standpoint, practically unaffected by the roasting; it is however more or less disintegrated by the alternate heating and cooling, and on that account is the better prepared for the smelter.

When the roasted ore is charged into the furnace the ferric oxide is reduced to ferrous oxide, which combines with the gangue to form a slag, while the nickel and copper retaining their sulphur unite with the remaining iron and sulphur to form a metallic bath

in the bottom of the furnace. This material, consisting as has been said of iron, nickel and copper combined with sulphur, is known as matte ; it contains the valuable constituents of the ore with the exception of slight quantities which pass off into the slag.

From the furnaces at Sudbury we have then at this stage two products ; a matte, averaging

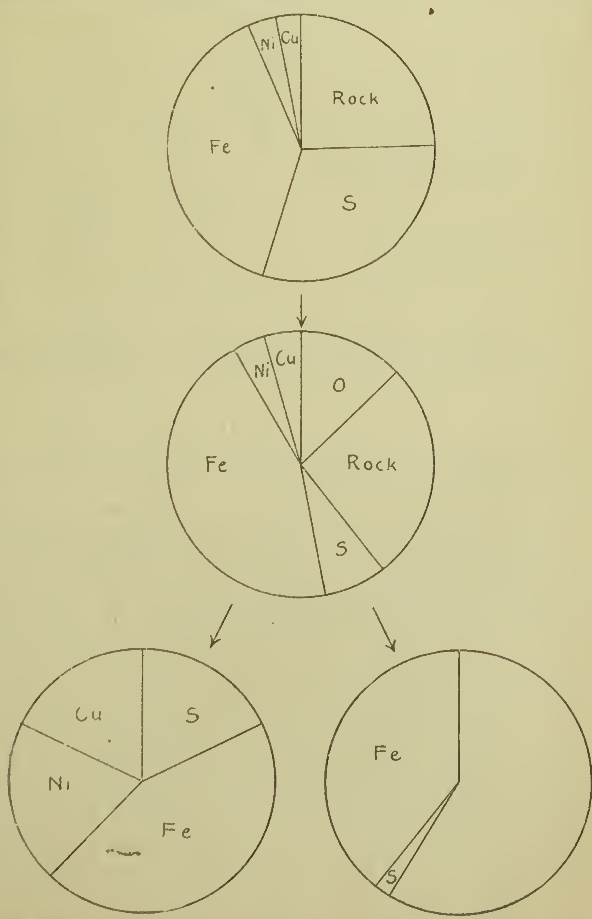
Copper	20-25 per cent.
Nickel	18-23 "
Iron	25-35 "
Sulphur	26-33 "

and a slag, containing 0.1 per cent. copper and a trace of nickel, which goes to waste. The former material is what is commonly referred to in the press as nickel matte, and at this stage it is shipped to the United States for further treatment.

Analyses of samples of these two products made by the writer are given below.

Matte.		Slag.	
Iron	43.90 per cent.	Silica	26.67 per cent.
Nickel	16 75 "	Ferrous oxide	50.82 "
Copper	19 87 "	Ferrous sulphide	3.52 "
Cobalt	0.63 "	Alumina	12.88 "
Sulphur	18.72 "	Lime	3.38 "
Slag	0.05 "	Magnesia	2.95 "
		Nickel	0.10 "
	99.92	Copper	0.20 "
			100.52

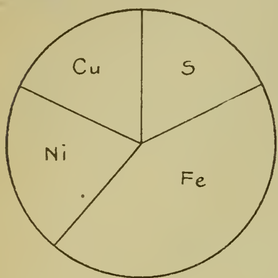
The diagram below represents graphically the chemical changes which take place in the treatment of the ore. The uppermost circle represents the composition of the raw ore ; the next circle lower, the composition of the roasted ore, which separates into two products matte and slag, whose component parts are shown in the two circles at the bottom. These latter two are simply graphical reports of the analyses given above.

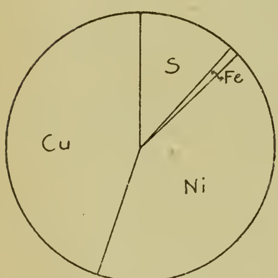


Eight or nine years ago the Canadian Copper Co. refined this ordinary matte still further by a process known as Bessemerizing, which consists simply in forcing a powerful blast of air through the molten material, an operation which causes so violent a reaction that no external heat is required.

The converter used was the Manhès' modification, and had a capacity of one and a half tons with a new lining and three tons with an old lining. The matte was run by troughs directly from the blast furnace to the converter, which was then wheeled to the chimney and the blast turned on. Starting at 5 lb. pressure, a violent agitation takes place, and on raising the pressure to 7 lb. white fumes of sulphur trioxide begin to appear. The color and appearance of the flame are no indication of what is going on in the converter. The end of the operation is judged rather by a perceptible diminution of the tem-

perature, not only of the flame but also of the particles splashed or blownout of the converter, and by the appearance of these particles which gradually become more frothy and at last issue in flakes about the size of the hand. This usually takes 40 to 50 minutes. The blast is then stopped, a few minutes is allowed for the settling of the metal, and the charge is poured. A lining usually lasts for five to seven blows.





During the operation a large proportion of the sulphur and almost all the iron is removed to form a slag with the siliceous lining, so that a mixture of copper and nickel sulphides containing roughly 80 per cent. of these metals is the product. The amount of nickel oxidized is trifling, the copper and nickel in the slag being invariably present in the same proportion as in the original and final matte, showing that the loss is merely due to grains of matte entangled in the slag. Cobalt is perfectly scorified, with but little oxidation of nickel, which might answer as a commercial method of separation; zinc, arsenic and antimony are completely volatilized; but bismuth, silver and gold are concentrated entirely in the matte. The change in composition during Bessmerizing is shown graphically in the annexed cut, in which the upper circle represents ordinary matte and the lower Bessemer matte.

Analyses of products are given in the following table:

Bessemer Matte.[1]			
Nickel sulphide	63.8	64.7	64.9
Copper "	32.4	32.1	33.9
Iron	3.8	3.2	1.3
Slag.[2]			
FeO	66.6		67.1
SiO^2	28.5		27.9
Cu	1.1		0.8
Ni	1.9		1.6
S	0.5		0.4

Bessemer matte.	(3)	(4)	(5)	(6)
Cu	43 36	45.71	48.86	44.87
Ni	39.96	40.93	31.35	41.18
Fe	0 30	0.40	0.81	0.94
S	13.76	....	....	11.62
Ag	7 oz	....	....	5.1 oz.
Au	0.1 0.2 oz.	....	....	0.3 oz.
Pt	0.5 oz.	....	....	......

According to the Canadian Copper Co. this rich matte was not so acceptable to consumers as the other of lower grade, and consequently the Bessemerizing was stopped.

THE ORFORD REFINING PROCESS.

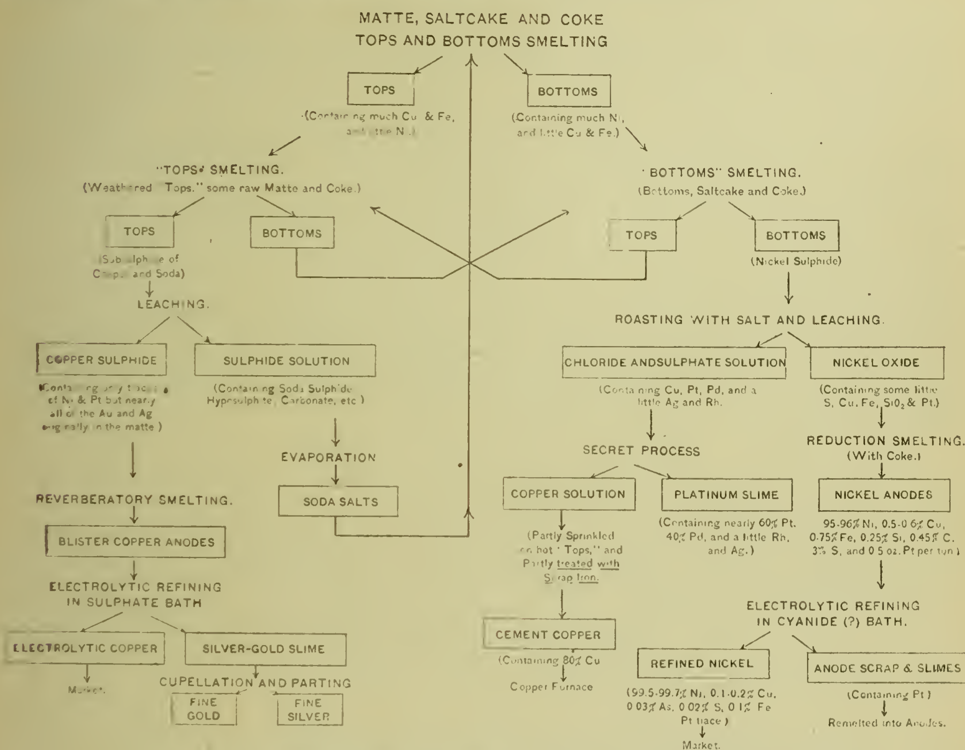
Almost all the ordinary nickel matte of the Canadian Copper Co. is refined by the Orford Copper Co. at Constable Hook, N. J., by what is known as the alkaline sulphide process.

This depends upon the fact that if a fairly rich nickel-copper matte be smelted with sulphate of soda and coal, the sulphides of copper and iron unite with the sulphide of soda produced in the process to form a very fusible mass, while the nickel sulphide which is of greater sp. gr. sinks to the bottom fairly free from the other two metals. Upon cooling there is a distinct line of separation visible, and the nickel sulphide in a yellowish white mass is readily removed from the dark iridescent iron-copper matte. These products are technically known as "tops" and "bottoms."

In practice the matte is smelted with salt cake, or crude sodium sulphate, a chemical which can be obtained cheaply, and two products result; tops containing nearly all the iron and copper as sulphides together with sodium sulphide, and bottoms containing all the nickel with small quantities of iron and copper. The tops are then exposed to the weather and the soda is gradually changed to the caustic condition in consequence. They are then smelted with fresh matte when the soda robs the nickel of part of its sulphur,

[1] Edwards, Eng. and Ming. Journ. May 2, 1896. [2] Ibid. [3] Ulke, Min. Ind. vol. iii, p. 460.
[4], [5] Roberts-Austen, Min. Proc. Inst. Civil Eng., vol. cxxxv, p. 30. [6] J. W. Bain.

producing once more a fluid mixture of iron, copper and sodium sulphides, while the nickel in a semi metallic state sinks to the bottom once more. By combining these two operations a pure sulphide of nickel with only very small quantities of copper and iron is obtained, which is simply roasted with a little sodium nitrate to produce the nickel oxide of commerce. If the metal be required, the oxide is mixed with some carbonaceous material and ignited ; it may afterwards be fused and cast as required. The following diagram of the Orford method was published in the Engineering and Mining Journal of July 3, 1897, accompanying a paper on the subject by Titus Ulke.



DIAGRAMMATIC SCHEME OF THE ORFORD METHOD OF TREATING NICKEL-COPPER MATTE.

The origin of the alkaline sulphide process has been the subject of some dispute recently, one party claiming that it has been invented but a short time, while the other holds that it is of much earlier date Some English patents of fifty years ago are interesting in this regard, and a few notes may find a place here.

Charles Schafhautl, in Patent 7994, issued September 5th, 1839, describing an improved method for smelting copper ores, makes the following statement : "I claim as part of my invention, firstly, the mixing of the ore with bodies of an alkaline nature which have an affinity for sulphur in order to decompose the sulphurets, or of mixing the same alkaline bodies and carbonaceous matter to decompose the carbonate of copper or the mixing the ore or metal to be calcined, roasted or smelted with carbonaceous matter—particularly plumbago or anthracite—and the said mixture of alkaline bodies and carbonaceous matter when the scoria or slack contains oxide of copper, and a mixture of carbonaceous matter and sea sand when the scoria or slack contains oxide of copper and metallic copper." In the case of ores containing 5 to 12 per cent. of copper, five parts were mixed with two and a half parts of quicklime and salt. The whole was then treated in a patent-calcining furnace and the product leached ; the residue was then smelted again. From the description it is plain that the inventor had found that a good deal of iron could be removed in this way, and probably in treating a nickel-copper ore he would have noticed that the copper would commence to pass into the supernatant

matte before the nickel. There is, however, no reference in the specification dealing directly with this point.

William Jeffries, in Patent No. 8557, dated January 1st, 1841, describes an improved method of treating copper ores in a reverberatory furnace by the addition of anthracite or common soda. His process does not appear to have any unusual feature, and the function of the alkali is somewhat indefinite.

William Gossage, in Patent No. 10,976, dated June 4th, 1846, gives an account of his improvements in the method of copper smelting: "The sulphureous ores and compounds of copper from which I obtain metallic products by the use of my invention are such ores and compounds as contain other metals than copper, such as tin, bismuth, lead, nickel and silver, or some of these." Hitherto copper had been purified by smelting such ores to bottoms too impure to be worked. "If the said 'bottom copper' does not contain such a proportion of silver as makes it desirable to proceed at once to the extraction of silver therefrom, I melt this with such a quantity of sulphureous ore or compound of copper as will yield sufficient sulphur to convert the 'bottom copper' into sulphuret, and I thereby obtain a sulphuret containing copper and other metals combined with sulphur, and I subject this sulphuret to such operations as are commonly used for obtaining 'bottom copper' and 'regulus' from sulphuret obtained from ores and compounds in the ordinary way. I thus obtain from such 'bottom copper' a certain portion of the copper (previously contained therein) in a state of sulphuret nearly free from admixture with other metals; also a new production of 'bottom copper' containing copper in a metallic state, combined with a larger proportionate quantity of other metals." There is here a definite scheme for the separation of nickel from copper by a smelting process, but it relies upon the addition of sulphureous ore instead of an alkaline material to supply the sulphur required.

That the alkaline sulphide process was in use previous to the entry of the Orford Copper Company into the field of nickel smelting is proven by a letter published in the Engineering and Mining Journal in August, 1893, from an ex-employee of the Vivian Company at Swansea, stating that the method had been employed for a number of years at that company's works. The separating furnace, a reverberatory, was charged with 3000 pounds of a mixture of salt cake, coal and matte; after smelting, the slag and tops were skimmed from the bottoms, locally known as "white." The slag and tops contain the copper, iron and other impurities, and the "white" is free from these. Pure nickel oxide free from copper was made at the works, but most of the shot metal was alloyed with copper according to the grade.

The Orford Copper Company were led to adopt the alkaline sulphide process by some experiments made on a small scale by their metallurgists, and great credit is due to them for the manner in which they have worked out the details. The following account of it has been supplied to the Bureau by Mr. Robert M. Thompson, the President of the Company:

"The United States Government purchased from the Canadian Copper Company a large amount of copper-nickel matte which was sent to my works to be refined. At that time we were not nickel refiners, but my relations with the navy were such, having formerly been a naval officer, that I was willing to do anything in my power to oblige them, so I set all my chemists and experts at the task of working out a process which would treat this matte. We started a process which did give us a product that the steel-makers could use, but which we found to be unsatisfactory and so costly that we were in despair. One day when visiting the works I noticed some pots of matte cooling in front of the furnace and observed that it had a different appearance from any I had ever before seen. I asked the superintendent what was the cause of it; he thought there was no reason, that it was a mere accident, but on appealing to the foreman he confirmed my belief that this matte was something different from anything before produced. The bottom of the cone was yellow, and the top was black. I had samples taken of each part and examined, and found that there was a concentration of nickel in the bottom and of the copper in the top. I then made an investigation, and found that the chemical department had had a cleaning out, and that a lot of residues had been thrown on the matte pile and put through the furnace, which was the means we used of getting rid of our waste products. I then examined my books for a period of a year to see what chemicals

had gone into the chemical house, and an investigation was started by my superintendent, Mr. John L. Thompson, and his assistant, Mr. Charles Bartlett, in which we tried experiments with all the chemicals known to have gone into that department. Finally we found the material which effected the separation. From this beginning a long series of experiments conducted on a large scale gradually worked out the process now known as the Orford process, which is to-day producing nickel as high as 99.7 fine. This is a brief history of our process."

THE BALBACH PROCESS.

The nickel produced by its own process at the Orford Company's works is not yet sufficiently pure for certain purposes, and some of the crude metal is sold to the Balbach Smelting Works, N. J., where it is further refined by an electrolytic process which remains a trade secret. The discovery of a satisfactory method for depositing nickel for the purpose of purification has been the object of much research. It is easy to plate a thin layer of the metal, but as the thickness increases a tendency to strip is noticed, and it becomes impossible under ordinary conditions to obtain coherent sheets suitable for rolling or working. This difficulty has been overcome at the Balbach works by some unknown method which Ulke, an authority on the subject, believes to consist in the use of a heated neutral solution of nickel sulphate for the electrolyte. It is well known that apparently trivial variations in electrolytic work produce results which appear to entirely incommensurate with the changes, and the working out of a commercial process is often dependent upon a happy combination of material. The Balbach Co. have produced plates of nickel 20″ x 30″ and $\frac{3}{8}$″ thick, which are so tough and elastic that they are as troublesome to work as so much tempered steel. The anode scrap may amount to 40 per cent. of the charge.

THE HOEPFNER AND FRASCH PROCESSES.

In the latter part of 1899 it was announced that a strong company under the title of the Hoepfner Refining Company, with a capital of $10,000,000, had been formed in Hamilton to refine nickel-copper mattes and zinc ores. These metals were to be obtained by electrolysis, using methods which had been developed by Dr. Carl Hoepfner, and a description of his cuprous chloride process may be of interest.

The basis of the Hoepfner method is the employment of chloride instead sulphate or cyanide solutions, and for the chloride process Dr. Hoepfner makes among others the following claims :

That they are better conductors of the current and are commercially cheaper. That they are applicable to the extraction of precious metals. That they prevent the deposited metal from becoming contaminated with sulphur. That they allow for the purification of the solution and its maintenance perfectly free from iron, arsenic, antimony, bismuth, etc.

A heated solution of cupric chloride containing 60 grams of copper per litre, and saturated with sodium chloride or calcium chloride, is passed into leaching drums containing the ore ground to 90 mesh, and is allowed to act for from two to six hours according to the nature of the material.

The operation takes place in two stages, thus : A fresh solution of cupric chloride is added to a drum of ore which has previously been treated in order to extract any of the remaining metals, and it then passes to a drum containing fresh ore where it is reduced to cuprous chloride. It is then drawn off, leaving a residue which in good practice does not contain more than 0.2 per cent. copper. The solution, now cuprous chloride, is run into vats and the impurities are separated ; silver by finely divided copper ; lead by cooling ; arsenic, antimony, bismuth and iron by oxide of copper or by lime.

The solution then passes in two streams to the depositing baths, which are so arranged that the electrodes are immersed in the two portions of the solution. Copper is deposited on the cathodes until the solution is entirely or almost entirely exhausted ; while at the anodes chlorine is liberated which re-converts the cuprous to cupric chloride.

These two streams flow into one common tank, and by their mixture we obtain once more a solution of cupric chloride with 60 grams copper per litre. The solution, now

purified from metals which would interfere with the next operation, is made neutral or is acidulated with some weak acid such as citric or phosphoric, and electrolyzed with the production of pure nickel. The anodes are insoluble, and are separated from the cathodes by nitrated linen or cotton mixed with asbestos ; the cathodes are rotating vertical or horizontal discs, with brushes.

It will be seen that the common trouble due to the unequal decomposition of the mattes and their consequent crumbling is entirely absent in this process. A curious advantage possessed by the Canadian ores over other nickel ores is due to the presence of small quantities of the precious metals. Thus a ton of Bessemer matte from the Canadian Copper Co.'s furnaces contains on an average 7 oz. silver, 0.1—0.2 oz. gold, and 0.5 oz platinum, worth at current prices $16. These metals, it is claimed, are entirely recovered by the Hoepfner process and constitute one of the valuable bye-products.

The supply of nickel-copper matte was to be obtained from the Nickel-Copper Company, Limited, which had been organized with the following officers : A. T. Wood, President ; John Moodie, Treasurer; and John Patterson, Secretary, to mine and smelt the Sudbury ores; but unfortunately the Hoepfner Company were not able to carry out their refining process with commercial success, and the Nickel-Copper Company took the matter into their own hands. The services of Mr. Hans A. Frasch were obtained and after experimenting for some time, he devised a process which is said to be at once efficient and cheap. On the 3rd September the Company announced that a public exhibition would be given, and a number of prominent men were invited to attend. Among these was Mr. Joseph Struthers of the staff of the Mineral Industry, who made a thorough investigation of the process and supplied a description which was published in the Engineering and Mining Journal of September 8, 1900. Mr. Struthers is a thoroughly competent metallurgist, and the details which he supplies may be fully relied on. The following description has been compiled from his article.

The process is based upon the electrolysis of a solution of common salt in the presence of the matte which is to be treated. As is well known the salt under the influence of the electric current is gradually decomposed into its elements, sodium and chlorine, the former reacting immediately with the water to form sodium hydrate, commercially known as caustic soda, while the latter, in the absence of any material with which it can combine, bubbles to the surface and can be drawn off in pipes. The matte, however, is readily attacked by chlorine, with the formation of chlorides of the metals which it contains, and this affords a ready method of dissolving the valuable constituents of the material under treatment.

In the electrolytic cell in practice, the matte, coarsely crushed, is placed upon the anode, which consists of a layer of carbonaceous material in the bottom of the vat. A layer of sand covers the matte and forms a diaphram for the separation of the solutions of caustic soda and the chlorides of the metals. The bottom of the vat is filled as far as the sand layer with a chloride solution, and water is added to fill the upper portion. As electrolysis proceeds the chlorine attacks the metals of the matte forming a solution of chloride which remains below, while the caustic soda solution is to be found above the layer of sand. It is claimed that the caustic soda and other bye-products will be sufficiently valuable to meet the entire expense of the process. The copper and nickel are to be removed successively from the solution by electrolysis.

An interesting feature is the proposal to use to the cupric chloride solution from the electrolytic cell for the treatment of new parcels of matte in precisely the manner described above in the Hoepfner process. At the public exhibition the solution of the ore was exhibited in an experimental plant, but the process has not yet been tested on a commercial scale. In addition, all reference to the most difficult problem, the deposition of the nickel, has been avoided in the published description, and until further work has been done it will be advisable to suspend any opinion.

THE LAKE SUPERIOR POWER COMPANY'S PROCESS.

It is commonly known that some American capitalists have invested a good deal of money in hydraulic works and pulp mills at the Canadian Sault Ste. Marie. For some time they were content to produce mechanical pulp, but finding that a good market

existed for sulphite pulp it was decided to enter upon its manufacture. For the production of this pulp it is necessary to use sulphur, and an inspection of the sources of supply led to some experiments with the nickeliferous pyrrhotite of the Sudbury region. It was found that the latter material on roasting gave a satisfactory quantity of the sulphur dioxide required, while there remained behind a mixture of iron and nickel containing still 7 per cent. of sulphur. This residue was mixed with lime and charcoal and smelted in electric furnaces with the following results:

In one case the mixture was contained in a vessel which acted as one electrode, the other being a carbon pencil moving perpendicularly; the product in this case consisted of 40 per cent. nickel, 28 per cent. iron, 12 per cent carbon and no sulphur.

In another instance the electrodes were placed side by side with a bridge between them, forming a continuous furnace which reduced the ore as fast as one man could shovel it in. In this case the material contained 7 per cent nickel and was high in carbon, and so hard that it offered great advantages as a cutting tool.

The company propose to enter upon this process commercially, and expect within a short time to produce daily 200 tons of ferro-nickel and to employ this alloy for the production of nickel steel rails at the rate of 500 tons per day.

PURITY OF NICKEL.

The purity of the commercial nickel in the market has steadily increased since its introduction, and a metal containing only very small amounts of impurities can now be obtained without difficulty. This will be made plain by a comparison of the table of analyses appended with that published in the Mineral Industry vol. I, p. 349. The analyses quoted below give the composition of some of the specimens of nickel on the market, with the exception of No. 7 which is a hitherto unpublished analysis of a bar of Wharton's nickel.

	1	2	3	4	5	6	7
Nickel	98.89	98.80	98.80	99.80	99.82	99.43	98.76
Carbon	0.40	0.16	0.16	0.05	0.07	0.087	
Silicon	0.02	0.09	0.09	none			0.26
Copper	0.10	0.11		none			0.10
Iron	0.43	0.60	0.60	0 13	0.10	0.43	0.91
Cobalt	0.14			none			
Manganese	0.02						
Sulphur		0.016	0.016	0.006	0.0068	0.0099	tr.
Tin		0 11					
Arsenic		0.11	0.11				none
Insoluble Residue						0.026	

1. American nickel, analysis by Foerster quoted by Ulke, Min. Ind. vol. vi, p. 505.
2. Cubes, Ferro-nickel Co., Inst. Civil Eng, 28 Mar., 1899.
3. Thompson nickel, Inst. Civil Eng., 28 Mar., 1899.
4. Mond nickel, Inst. Civil Eng, 28 Mar., 1899.
5, 6. Mond nickel, Proc. Inst. Civil Eng., Nov. 8th, 1898.
7. Wharton nickel, analysed by J. W. Bain.

USES OF NICKEL.

Nickel is used chiefly in the production of nickel-steel, a material which has come rapidly into favor on account of its excellent qualities. Much has been written during recent years concerning this new steel, and it would far exceed the limit of this paper to give an adequate account of the discussion. Two excellent contributions to the subject were made in 1899 by R. A. Hadfield[1] and David H. Browne[2] and many details will be found in these papers.

Nickel-steel has many uses and is daily being tried for new purposes. Perhaps the most important use to which it is put is for the manufacture of armor and heavy

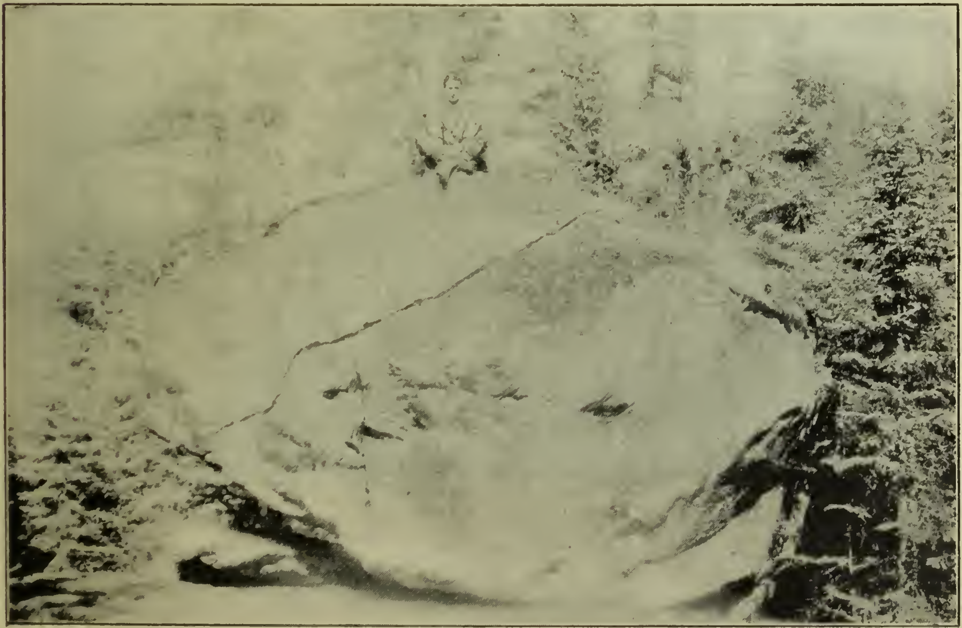
[1]Proc. Inst. Civil Eng. Mar. 28, 1899. [2]Trans. Am. Inst. Mng. Eng. Sept. 1899.

ordnance, where its great strength and toughness are of much value. It has been used for engine and propellor shafts for a number of years, and has proven so much superior to other steels that it is unrivalled for such purposes. Because of increase of strength or decrease of weight, it has been used for piston rods, crank pins, light forged engine frames, bolts for extreme hydraulic pressures, hydraulic forged cylinders and railway axles; and from its peculiar resistance to fatigue under vibration it is used very successfully for piston rods in steam engines and rock drills. The value of nickel-steel for armor plate lies not in greater resistance to penetration, but in non-fissibility. It resists penetration admirably, it is true; but when the projectile does pierce, a clean hole is produced without shattering, and this is a feature of much importance in armor. The United States Bureau of Ordnance in a number of tests have decided on the superiority of Harveyized nickel-steel over all other competitors. An idea of the quantity which is thus consumed may be gathered from the statement that if the armor of the battleship Massachusetts carried $3\frac{1}{2}$ per cent. nickel, 75 tons of that metal would be required in its manufacture.

Nickel has a number of minor uses in the arts, of which its employment for alloys and plating may be mentioned. German silver is a well known alloy of nickel, and much of the plated ware now produced has as a body an alloy containing nickel which is so white in color that the difference between the superficial plating and the base metal is very much less apparent than when brass is used as a body. Considerable quantities of nickel salts are used for plating purposes; the most common of these is nickel-ammonium sulphate. Nickel coinage has been introduced into a number of countries with satisfactory results, as in the United States, Switzerland, Belgium, Peru, Jamaica, Brazil, Chile, Germany, Japan, Mexico, Bulgaria and the Argentine Republic.

Such are some of the uses to which this metal is put, and the list is increasing constantly. A glance at the table of statistics given previously will show a steady annual increase in the output, which is probably due chiefly to the increased demand for nickel-steel armor and ordnance. Although Canada produced in 1898 only 40 per cent. of the world's output the industry is now on a firm basis, and in the near future the operations of the new companies which are entering the field should, if all goes well, alter the ratio until the balance lies substantially to the credit of our domestic ores.

48. Rapids on Trout River, p. 136.



49. On the North Slope of Mount Horden, Algoma District, p. 137.

50. A Nickel Mine in New Caledonia, pp. 213-215.

51. Convict laborers at work in a Nickel Mine, New Caledonia, pp. 213-215.

52. Ore dump and wire tramway at Nickel Mine, New Caledonia, pp. 213-215.

THE MINES LAW OF ONTARIO[1]

By Archibald Blue

In Ontario, as in all the older Provinces of Canada, the Legislature may exclusively make laws in relation to the management and sale of public lands. The Province is the owner of all unoccupied lands within its boundaries, excepting areas which have been set apart as Indian Reserves; and even on these reserves the title to gold and silver, if not to all ores and minerals, is vested in the Crown as represented by the Executive of the Province.

In the early period of our history mines, minerals and ores were not deemed worthy of being dealt with by statute law. During the first thirty years all mines of gold, silver, tin, lead, copper, iron and coal were reserved to the Crown in the patents, and in the next forty-four years all mines of gold and silver were so reserved. For three quarters of a century regulations made by Order in Council were the only mining laws. But this was largely owing to the fact that the southern portions of Ontario, which were the first to be occupied, were valuable chiefly for agriculture. It was only when exploration began to be carried northward into the regions of the Archæan rocks around lake Huron and lake Superior that evidence began to accumulate of the existence of valuable ores and minerals, and then the importance of making laws to regulate the sale of mining lands and the conduct of the mining industry began to force itself upon the attention of the Legislature. It was known eighty years ago that deposits of iron ore existed in the eastern part of the Province; but the valuable discoveries of minerals south of lake Huron, Georgian bay and lake Nipissing are comparatively modern. Gold, copper, corundum, arsenic, mica, apatite, gypsum and salt occur over a wide area, and some of them in great bodies. Yet, with the single exception of gold, a knowledge of the presence of these minerals in lands occupied by farmers and lumbermen did not weigh a grain in the mind of the Legislature,—no doubt owing to the fact that in some cases the Crown had parted with its interest in the lands. In the western counties, between lake Huron and lake Erie, there is an area of about 1,200 square miles underlaid with thick beds of salt, sufficient in amount to supply the world for millions of years; but nearly the whole of this tract of land, with its timber and minerals, was sold to settlers a quarter of a century before the first discovery of salt within its limits. In the eastern counties within the last four years a discovery of corundum was made which has been proved by exploration conducted under Government auspices to have an extent of four hundred square miles. In this instance, however, the lands are mostly in homestead districts, where the minerals are held as the property of the Crown, and they are disposed of under conditions which call for development and the erection and maintenance of works in the Province to manufacture the various products of the ore. But in all its main features the Mines Law of Ontario owes its origin and evolution to circumstances connected with the discoveries of minerals in the northern districts—in the territory popularly known as New Ontario.

It is not the purpose of this paper to deal with the subject historically, for this would occupy too much time. It must suffice to describe the law as it is, merely premising that, like most other laws, it is a product of experiment, and that no "Finality John" has had part in the shaping of it.

FEATURES OF THE PRESENT LAW.

The law is known by its short title as "The Mines Act," and among its first provisions are sections which abolish all royalties upon ores and minerals, and that rescind and make void all reservations of mines, ores and minerals contained in any patent, except patents issued for agricultural lands under the Public Lands Act or the Free Grants and Homesteads Acts.

Any person, citizen or foreigner, may explore for mines or minerals on any Crown lands, whether surveyed or unsurveyed, except such as may have been withdrawn from sale, location or exploration as being valuable for their pine timber or for any other

[1] A paper read at the International Mining Congress, Milwaukee. It embodies the principal features of the Act as amended in the Session of 1900.

reason, and any person attempting to explore, occupy or work any lands so withdrawn is liable to a penalty. The main object of this provision is to protect areas which have been sold as timber limits, where the pine is liable to be destroyed by the carelessness of prospectors in building camp fires. Sections which are shown to be rich in ores or minerals may also be withdrawn from sale or lease, pending a careful exploration under the direction of the Commissioner of Crown Lands, and the price of lands in a section so proven to be valuable may be fixed at any greater sum than the Act provides, or the lands may be offered for sale at public auction on such terms and conditions as may be fixed by Order in Council.

When Crown lands are situated within a mining division, and are held and worked under miners' licenses, they are known as mining claims; but when they are situated elsewhere, and are supposed to contain ores or minerals, they may be held or leased as mining lands in blocks or lots called mining locations.

In unsurveyed territory a mining location is required to be rectangular in shape, with the bearings of the outlines due north and south and east and west astronomically, with an area of not less than forty acres and sides of 20 chains, or with areas which are multiples of forty acres, as 80, 160, 320. In surveyed townships a location may be a fractional part of a lot or section, but so that its area shall be not less than forty acres; and, where road allowances have not been laid out, a reservation of five per cent. of the land is made in the patent, and the Crown or its officers may lay out roads where deemed necessary.

In unsurveyed territory mining locations are required to be surveyed by a licensed surveyor at the cost of the applicants, and to be connected with some known point in previous surveys, or with some other known point or boundary so that the tract may be laid down on the office maps of the territory. The surveyor's plan, field notes and description must be furnished to the Department of Crown Lands within four months of the time of application for the lands, and they will not be regarded as constituting a claim to the location on behalf of the party at whose instance they have been prepared unless they are filed in the department immediately upon completion of the survey. The applicant is required in addition to furnish evidence of the discovery of valuable ore or mineral in the land, as well as evidence of no adverse claim by reason of prior discovery or occupation as far as known to him, and to pay one-fourth of the purchase price or first year's rental within sixty days, and the balance within three months from the date on which his application was filed in the department. The area which any person may acquire in one calendar year of lands containing ores of the same class or kind is limited to 320 acres within a radius of fifteen miles in any one district or county, which may be composed of separate locations of not less than forty acres each; and no firm, syndicate or incorporated company may acquire more than 640 acres in one year. For every distinct kind of ore discovered within the radius of fifteen miles, the maximum area of land may be taken up in the same year; and so with any discoveries made outside of the radius of fifteen miles. But in case a prospector does not see fit to incur the expense of making a survey of a location and paying the price therefor before he has had an opportunity of proving its value, he may procure from the Commissioner of Crown Lands a miner's license, which will authorize him to stake out and work two mining locations in unsurveyed territory within a radius of fifteen miles, and hold them for a period of two years subject to an expenditure of three dollars per acre in the first year and seven dollars per acre in the second year for actual mining work. If then satisfied that the land is valuable, he may proceed to acquire it in the regular way. In the case of a prospector who is the first discoverer of valuable metals, ores or minerals upon a vein, lode or deposit not less than five miles from the nearest known occurrence of the same kind of metal, ore or mineral, he is entitled to a free grant of one location of forty acres.

HOW MINING LANDS MAY BE ACQUIRED AND HELD.

Mining lands may be acquired in fee simple upon payment of the price fixed in the Act, or may be taken up under lease tenure subject to the payment of a yearly rental. Both price and rent are regulated by distance from a railway. If a location is in surveyed territory, the price is $3.50 per acre when within six miles of a railway, $3 if within twelve miles, and $2.50 if more than twelve miles from a railway; and prices are

50 cents per acre less in each case if the location is in unsurveyed territory. The rent charge is uniformly $1 per acre for the first year, 30 cents per acre in subsequent years if the location is within six miles of a railway in surveyed lands, 25 cents it within twelve miles, and 20 cents if more than twelve miles, with a reduction of five cents per acre in each case if the location is in unsurveyed territory. At the end of ten years, if the rent has been paid and the necessary working conditions have been performed, the lessee is entitled to receive a patent for his location free from all conditions, or he may obtain a patent at any time during the demised term upon payment of rent for the full period and performance of all the covenants and conditions of the lease. In practice the lease system provides an easy term of payment, as the aggregate amount at the end of ten years is a mere trifle more than the cash price for a patent. But whether acquired in fee simple or under a lease, a location is held subject to an expenditure for actual mining operations of a sum not less than $6 per acre during the first seven years immediately following the issue of the patent or lease, whereof $1 per acre must be expended in the first two years and $1 per acre in each of the following five years; and if two or more locations are contiguous, the whole of the mining work may be done upon one of them. In default of such expenditure all rights of an owner or lessee are liable to forfeit, and the land is subject to reversion to the Crown. In the case of lands valuable for iron ore, and where it is reported by an inspector or other officer that a mine may be profitably worked, the owner or lessee may be required to raise 2,000 tons a year for a period of ten years, or 20,000 tons in a shorter period of time when the location is not more than forty acres and a proportional amount if it is more than forty acres, with liability to forfeit of title if the requirement is not complied with. Failure to pay yearly rent subjects a lease to forfeiture, with reversion of the land to the Crown; but in case of a co-lessee or co-owner who defaults in rent or performance of working conditions, his interests may be vested in his co-lessees or co-owners who have paid the rent or made the expenditure for working conditions, when delinquency is proven to the satisfaction of the Commissioner.

Pine trees on lands sold as mining locations are reserved to the Crown in the patent, and any person holding a license to cut timber or sawlogs on such lands may at all times enter upon the lands and cut and remove such trees, and make all necessary roads for that purpose. The patentee, however, may cut and use trees necessary for building, fencing and fuel on the land, or for any purpose essential to the working of the mines, and may also cut and dispose of all trees required to be removed in clearing the land for cultivation. All pine trees cut on a location except for these purposes are subject to the payment of the same dues as are at the time payable by the holders of licenses to cut timber or sawlogs. If a location is held under lease, and in case it is intended to clear any portion of the land for cultivation, the lessee is required to give the holder of the timber license three months' notice, and if at the expiry of that time the timber has not been cut and removed by the holder of the license the lessee may cut and dispose of it, subject to the payment of the same dues as are at the time payable by the holder of the license. Timber other than pine upon a leased location may be cut for building, fencing and fuel, or in the course of clearing for cultivation, or for any purpose essential to the working of the mines; but none shall be cut for any other purpose except with the authority of the Commissioner, and subject to the payment of dues at the rate to be fixed by the Commissioner.

Where the surface rights have been granted for agricultural purposes, the mining rights may be acquired by a prospector who is the discoverer of ore or mineral thereon at one-half the price or rental of mining lands, subject to compensation for injury or damage to the surface rights; and in case the owners of the surface and mining rights cannot agree, the Director of the Bureau of Mines may prescribe the manner in which compensation shall be ascertained and paid or secured.

TENURE OF CLAIMS IN MINING DIVISIONS.

Whenever the Government of the Province sees fit, it may by Order in Council set apart any tract of country described in the order as a mining division, and may from time to time add to, diminish or cancel the division by an Order. Lands held for mining purposes in such a tract are known as mining claims, and the tenure is one of occupation by any person, partnership or mining company holding a miner's license. Licenses are granted for one

year on payment of a fee of $10, and are renewable from year to year. They authorize the licensees to explore any portion of the mining division, and to mine on any claim marked or staked out by themselves on crown lands; but any person may be employed by a licensee to work his claim, or he may organize a company to work it, or may transfer it to another licensee. Discovery of a vein, lode or other deposit of ore is a prerequisite to the staking out of the claim, and it is deemed to be staked when a discovery post is planted upon an outcropping of ore or mineral in place within the boundaries of the claim, and a stake is planted at each of the four corners, numbered in order from the northeast to the northwest corner. A claim may be a square of fifteen chains, contain- $22\frac{1}{2}$ acres, or of any other extent greater or less as may be fixed by regulation, but so as not to exceed a square of 20 chains containing forty acres, and the ground included in each claim is deemed to be bounded under the surface by lines vertical to the horizon. A licensee who has staked out a claim is required within thirty days to register it with the Inspector for the division by filing under oath an outline sketch of the plan, showing the discovery post and corner posts and their distances from each other, together with a notice in writing setting forth the name of a licensee, the locality of the claim as indicated by some general description, the time when it was marked out, the length of the boundary lines if for any cause they are not regular, the situation of the discovery post and the date of the record; and the Inspector is required forthwith to enter the particulars of the notice in his book, and file the notice and sketch or plan of the claim with the records of his office. If the licensee fails to comply with the requirements for registration, or if, having complied with them, he or any person on his behalf removes any post for the purpose of changing the boundaries after the plan and notice have been filed, the claim shall be deemed to be forfeited and all the rights of the licensee in it shall cease. A claim may also be forfeited if the miner's license has run out and has not been renewed, or if the annual fee has not been prepaid in the case of a licensee who is the holder of more than one claim, or if a sum of $150 has not been expended upon it in actual mining work. No more than one claim may be staked out upon the same vein, lode or deposit of ore by an individual licensee, unless it is distant at least sixty chains from the nearest known mine, claim or discovery on the same vein or lode; but no licensee may stake out and record in the same mining division more than four claims in one calendar year within a radius of fifteen miles, and for each additional claim after the first a fee of $10 is required. A licensee who is the holder of five claims or less within a radius of one mile may carry on all mining operations demanded by the Act upon one of them, or different persons holding claims within a radius of one mile may combine to expend all operations on one claim for every five claims or less.

When the working conditions have been complied with for a period of four years on a claim of 20 chains square, or for three years on a claim of 15 chains square or less, or when an equivalent of such working conditions has been complied with in a less period of time, the licensee may apply for and obtain a certificate of full performance of working conditions for the claim free from any other working conditions, renewal fee or miner's license. He may also, if he desires to hold the claim under a patent or lease, proceed to get a survey made of it as a mining location, and pay in the purchase money or first year's rent at the rates fixed by the Act for mining locations. This provision, however, is not for the sake of securing a better title, but to satisfy a desire for better description by metes and bounds, a holding under the great seal, and the right to record in the office of the Register of Titles.

THE BUREAU OF MINES.

Other provisions of the Mines Act relate to mining regulation for the health and safety of men employed in mines and mining work, and for the punishment of offences against the Act. There are also provisions for administration under the office of the Bureau of Mines, which was organized to aid in promoting the mining interests of the Province. The inspection of mines, the conduct of exploratory work under direction of competent geologists, the operation of diamond drills and the encouragement of iron mining by the payment of a bonus to miners for ores smelted in the Province, are all within the sphere of the Bureau's operations.

EXPLORATION OF UNKNOWN ONTARIO.

During the present season ten exploration parties have been organized to make a careful examination and report on the northern regions of Province. This territory extends from the Quebec boundary on the east to the Manitoba boundary on the west, a length of about 700 miles, and its area is about 90,000 square miles, or about 40 per cent. of the whole Province. It is one and a half times larger than the whole State of Wisconsin, and nearly twice as large as the Orange Free State; but excepting along the lines of its canoeable waters it is as little known as the Congo Free State in the heart of Africa. Almost certainly it is a region in which there are great forests of spruce and other kinds of trees, valuable for pulpwood; there are wide tracts of clay loam deposited in ancient lake bottoms, as well as large areas of till, both of which are calculated to form the best of farm land; and there are many thousands of square miles of the Archæan formations in which the trained prospector may hope to find rich stores of ores and minerals.

PROVISION FOR REFINING NICKEL ORE.

I have kept for the close of my paper reference to a new provision of our Mines Act, which, however, has not yet been brought into operation. Its purpose is to secure to Ontario a larger share of an industry which in recent years has been built up out of raw materials which the Province possesses in large abundance, namely, the refining of nickel and the production of nickel steel. Two works with ample capital are in course of construction for the production of steel, the refining of nickel and the manufacture of nickel steel, and one if not both of them includes in its scheme a plant for the making of nickel steel rails for railways, at a cost estimated to exceed but a little the cost of Bessemer rails. For this industry Ontario is well favored by its supplies of the raw materials, and, if deemed necessary for the object in view, effect will be given to the provision of the law when the works are equipped and practically established. Stated in its briefest terms, the provision requires that every person carrying on the business of mining nickel ore in the Province shall pay to the Treasurer of the Province a license fee computed at or below a fixed maximum rate upon the gross quantity of ore raised or won by him during the preceding year, with a right to remission if the ore has been treated in the country so as to yield fine metal, or other form or product of the ore suitable for direct use in the arts without further treatment. But, until brought into force by proclamation of the Lieutenant-Governor in Council, this provision shall not take effect.

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